THE SEASONS PICTURED

IN 48

SUN VIEWS

OF THE

EARTH

AND 24

ZODIACAL MAPS

WITH OTHER DRAWINGS.

BY

RICHARD A. PROCTOR,

Author of
"The Stars in their Seasons,"
"A Library Star Atlas," "A School Star Atlas," &c.

Look downward on that globe whose hither side
With light from hence, though but reflected, shines;
That place is Earth, the seat of Man; that light
His day, which else, as th' other hemisphere,
Night would invade . . . .

MILTON.

. . . . Heav'n
Is as the Book of God before us set,
Wherein to read His wondrous works, and learn
His seasons,—hours or days or months or years.

MILTON.

LONDON:

LONGMANS, GREEN, & CO.

AND NEW YORK: 15 EAST 16th STREET.

PLATE I.—Frontispiece.

The Earth's Path round the Sun.

[*The dots outside the circle AA' may be regarded as showing the earth at intervals of one day, on her annual course, only her globe is relatively very much smaller even than these small dots.*]

THE SEASONS PICTURED

IN

FORTY-EIGHT SUN VIEWS OF THE EARTH

AND

TWENTY-FOUR ZODIACAL MAPS & OTHER DRAWINGS,

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RICHARD A. PROCTOR,

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Extracted for "Knowledge Library" from "Knowledge" for 1883 and 1884.

LONDON:
LONGMANS, GREEN, & CO.
1885.

WYMAN AND SONS, PRINTERS,
GREAT QUEEN STREET, LINCOLN'S-INN FIELDS,
LONDON, W.C.

INTRODUCTION.

THE object of the series of pictures and maps in the present work is to illustrate more fully and satisfactorily than has hitherto been done, the cause and nature of the seasons, and to bring clearly before the student's mind the nature of the sun's path along the ecliptic, the central track of the great zodiacal zone. For this purpose I show first, in the frontispiece, the path of the earth around the sun, then in a series of twelve plates the varying presentation of the earth's surface towards the sun at four different hours of the day, in each of the twelve months of the year. These forty-eight views, each repeated three times, in order that the relations of the seasonal changes may be more clearly recognised, are followed by a series of views of the British Isles at midday in winter, spring or autumn, and midsummer, and at six morning and evening at midsummer. All these views may be called Sun Views of the Earth. They are followed by twenty-four zodiacal maps,—viz., twelve maps showing the zodiacal zone with the ecliptic, meridians, and declination parallels, and the sun's course from day to day all the year round, the sun's disc being shown of its true size and in its true place for each day in the year: the stars, meridians, &c., are shown in these maps dark on a white ground. Then follow twelve maps showing the zodiacal zone with stars only (meridianal and ecliptic divisions are marked in as minute crosses), the stars showing white on a dark ground.

Taking the frontispiece—Plate I.—first, we see in it the earth's path ABA′B′ around the sun at S, the point C being the centre of the path, AA′ its longer, BCB′ its shorter axis. The eccentricity SC is very obvious, on the scale of our diagram, but the ellipticity is not noticeable: in other words CA and CA′ are not measurably different in length from CB and CB′, or AA′ from BB′. This many find inconsistent with the idea derived from the familiar statement that the earth's path is an ellipse; for the path seems to be a circle around C as centre. The path is really elliptical; but, on the scale of our picture, the ellipticity is not recognisable. Speaking with sufficient closeness to the facts for our purpose here, SC is about the sixtieth part of CA or CA′, and SB is equal to either CA or CA′. Hence, since SCB is a right-angled triangle, the square on CB is less than the square on SB by the square on CS, or by only 1-3,600th part of the square on SB. Whence it follows (the student can readily satisfy himself of this by calculation) that CB is less than SB by only 1-7,200th part of SB. If AA′ were $7\frac{1}{5}$ in. (it is really only about $6\frac{1}{2}$ in.), BB′ would be less by only 1,000th part of an inch.

Placing ourselves in imagination at S, we should see the earth carried round the circle ABA′B′, travelling along the distance from dot to dot round this circle in

one day, and appearing to turn once round on its axis each day. I say *appearing* so to turn because as a matter of fact it is only to an observer at S that an exact rotation seems to be made in each day of our ordinary time. Evidently the earth has to turn a little more than once round to bring the same face towards S, when she has reached the end of each day's travel, as she turned the day before. In a quarter of her annual circuit he shas, in all, made one extra quarter rotation in this way; in half of her circuit, a half rotation; and in the whole year a full rotation more. Thus the earth turns on her axis not $365\frac{1}{4}$ but $366\frac{1}{4}$ times in a year, or $365\frac{1}{4}$ solar days are equivalent to $366\frac{1}{4}$ true rotations,—called sidereal days because they are the days we should have if we considered the earth's rotation as supposed to be seen from a star. Viewing the matter from the earth instead of the sun we may say that the sun appears to take a longer time in returning to the south, day after day, than a star does; the reason being that as viewed from the earth the sun is all the time travelling eastwards, or in a direction contrary to that of his apparent daily motion; and as he makes one eastward circuit in a year, he loses one apparent circuit of the heavens in making $365\frac{1}{4}$. The mean solar day is thus longer than the sidereal day, or true rotation-period of the earth, by slightly less than 1-366th part of a day, or about four minutes.

Now let us suppose our observer at S, the sun, to watch the earth as she traverses the orbit ABA′B′, considering first her apparent axial pose only. As her real axial pose remains unchanged during her entire circuit (for we may neglect that slow reeling movement which is accomplished in 25,900 years, as not producing any change in a single year,—at least none which need be considered here) it is manifest that the apparent axial pose will vary precisely as though the earth remained at rest, and our observer travelled round her. But also, we get just the same changes in the appearance of an object by travelling around it, as we would if the object were turned round on an axis square to our path of circuit. So we shall get all the changes of the earth's apparent axial pose, as viewed from the sun, by supposing her centre at rest, and her globe twirled around an axis square to the plane of the ecliptic:—

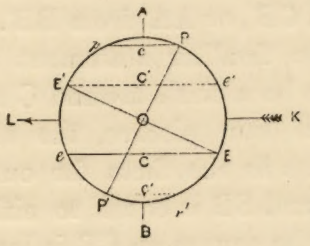


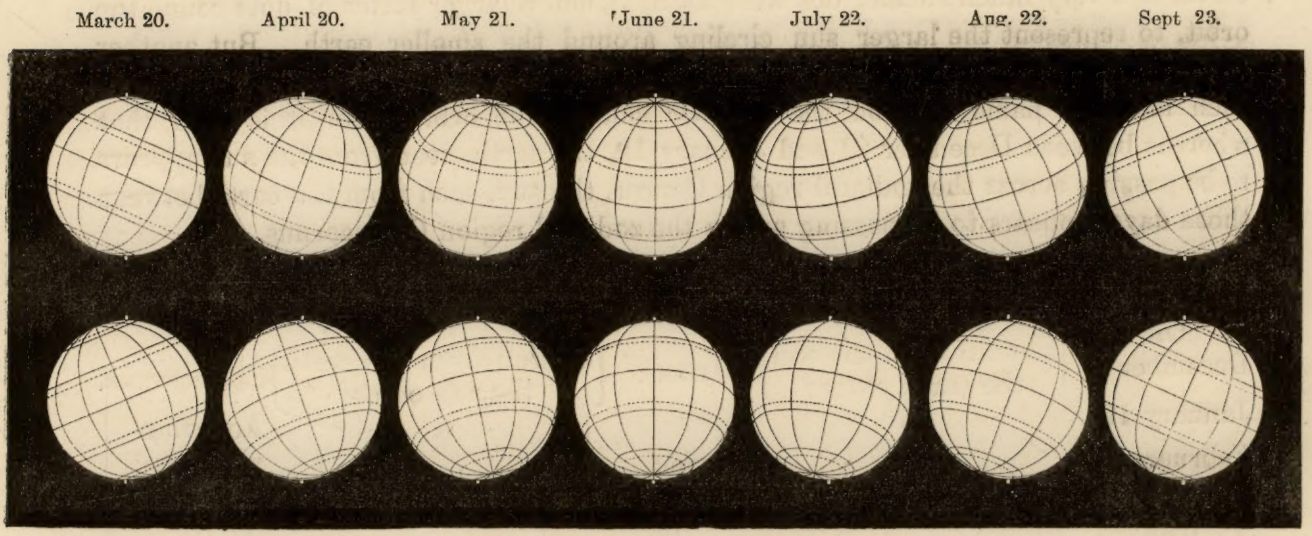
FIG. 1.

Thus suppose PEP′E′ a view of the earth on about March 20, when the polar axis is as shown, and the equator seen like a straight line across the centre of the disc, as EOE′, the arrowed line KOL representing the earth's motion as watched from the sun:—Then E will be brought into view and E′ carried out of view as the

earth goes on; P, the north pole, being brought within the visible part of the earth, and P′, the south pole, being carried to the invisible part. It is clear that we simplify our study of these changes, without any loss of fulness, by supposing the earth's globe to turn round the upright axis AB (square to KOL).

It is obvious that E will be carried along the line EC*e* parallel to KL, and E′ along the corresponding line E′C′*e*′ on the unseen half of the earth. The pole P will be carried along the line P*p* on the visible half, and the pole P′ along the corresponding line *p*′P′ on the unseen half, of the earth, P*p* and P′*p*′ being parallel to KOL.

The actual changes in the earth's aspect from month to month are shown in the following figures:



FIGS. 2–15, ILLUSTRATING THE EARTH'S VARYING PRESENTATION TOWARDS THE SUN THROUGHOUT THE YEAR.

Now, the first twelve plates in this work show the earth in these twelve aspects, at four hours in each day, viz., at 6 A.M., noon, 6 P.M., and midnight, Greenwich mean solar time, each plate giving the aspects during three successive months, so that the progress of the change in the earth's aspect can be traced on from month to month, but always with the aspect for the preceding and following months visible for comparison.

Observe also that any face of the earth shown for any named date and hour represents the face of the earth turned *from* the sun at that hour *six months later or earlier* than the dates named on the maps; or the face of the earth turned directly *towards* the direction in which the earth is travelling, at that hour, *three months later;* or the face turned directly *from* the direction in which the earth is travelling, at that hour, *three months earlier* than the dates named on the maps.

To illustrate the effect of these changes in modifying the amount of sunlight received by any part of the earth's surface, Plate XIV. is added, in which we see the aspect of the British Isles, Denmark, and parts of France, Sweden, Germany, &c., at midday in midwinter, spring, or autumn, and midsummer, and also the aspect of the same regions at six on a midsummer morning, and at six on a midsummer evening.

Again, viewing the earth from S, we see from the frontispiece, that she travels from right to left, or from west to east among the stars. The names of the signs outside the orbit indicate the directions in which the various signs lie as seen from S. On or about December 21 the earth as seen from the sun enters the sign Cancer, passing out of Cancer and into Leo on about January 19, into Virgo on about February 18, into Libra on about March 20, and so on.

The frontispiece would also represent the apparent path of the sun around the earth, if a very much smaller dot were set at S, and a larger series of dots round the orbit, to represent the larger sun circling around the smaller earth. But another change would have to be made. The names of the signs would have to be altered, each into the name now on the *opposite* side of the orbit. For it is clear that whereas between December 21 and January 19, the earth, seen from the sun appears to be passing across the zodiacal region Cancer, the sun, seen from the earth between those days, appears to be passing across the zodiacal region Capricornus.

Thus,—

On December 21	{as seen from the sun the earth enters}	Cancer :	{as seen from the earth the sun enters}	Capricornus.
January 19	,,	Leo :	,,	Aquarius.
February 18	,,	Virgo :	,,	Pisces.
March 20	,,	Libra :	,,	Aries.
April 20	,,	Scorpio :	,,	Taurus.
May 21	,,	Sagittarius :	,,	Gemini.
June 21	,,	Capricornus:	,,	Cancer.
July 22	,,	Aquarius :	,,	Leo.
August 22	,,	Pisces :	,,	Virgo.
September 23	,,	Aries :	,,	Libra.
October 23	,,	Taurus :	,,	Scorpio.
November 22	,,	Gemini :	,,	Sagittarius.

The sun's path and his position from day to day, are shown in the twelve zodiacal maps forming Plates XV., XVI., XVII., XVIII., XIX., and XX., while the same zodiacal regions are shown, on the same scale, but without meridians and parallels, in the series of Plates XXI., XXII., XXIII., XXIV., XXV., and XXVI. It will be observed that each of the twenty-four zodiacal maps shows a *sign* of the zodiac, and on either side of the sign a strip five degrees wide belonging to the sign

preceding or following. Thus the maps overlap to a convenient degree. The zodiacal zone is about twenty-seven degrees wide, so that the paths of all the planets, as seen from the earth, would be included well within its width.

These maps may be conveniently used for other purposes. Thus, to determine the point towards which the earth is travelling on any day, say November 13 :— From Frontispiece, we see that the earth on November 13 is in the twenty-second degree of the sign Taurus, and therefore travelling directly towards the twenty-second degree of the sign Leo, three signs or one quadrant farther forward; the corresponding point, called the apex of the earth's way, is seen in the first Map of Plate XVII. (it is near the place occupied by the sun's centre on May 12). The same point, also shown in the first Map of Plate XXIII., is on the ecliptic, near the star τ_2 in Aries. So may all such cases be dealt with.

Lastly, Plate XXVII. shows the varying diurnal path of the sun in the sky in the latitude of London, from month to month throughout the year. It also shows, in the loop on the southern meridian, how the sun's position at clock noon ranges on either side of the southern meridian throughout the year. A study of the sun's path, as shown in the Frontispiece and in Plates XIV. to XIX. will explain why his midday position thus varies :—

Thus in the early spring months, we see from the Frontispiece that the earth is travelling faster than her mean rate, being nearer the sun than her mean distance. The real sun therefore passes to the east faster than the mean sun, the imaginary body (travelling uniformly once a year round the equator) which rules our clocks. The sun gains more also in eastwardly motion athwart the hour circles, during the first half of this quarter, because (as we see from the zodiacal maps for January, February, and March) he is here crossing the meridians where they lie nearer together than at the equator. Here then he gains rapidly in advance eastwards, and therefore, since the diurnal motion carries him *westwards*, he follows the clock sun in coming up to the meridian,—or clock time is before solar time.

The latter cause of the sun's excess of eastwardly motion is reversed in the latter half of the first quarter, and so far as it is concerned he would come to the meridian at clock noon at the time of the vernal equinox. For as the zodiacal maps show, he now has a slant motion athwart the hour circles, and their distance apart is also widening to its full equatorial value, insomuch that losing at this time he has just travelled one-fourth of the circuit of the hours in this fourth of his circuit of his own path, the ecliptic. But a balance of gain remains, because the gain due to the sun's more rapid apparent motion of revolution (see the Frontispiece), is not corrected till the earth is in aphelion about July 2. The lagging of the sun owing to his slant course athwart the hour circles presently works off the balance of former gain (for in March and April the sun is nearly at his mean distance), and so, about April 15, the sun's position at clock noon is on the meridian, or clock and sun are together.

He next makes a westwardly range owing to his slower motion across the hour circles, which is presently corrected as he ranges north of the ecliptic, and he comes

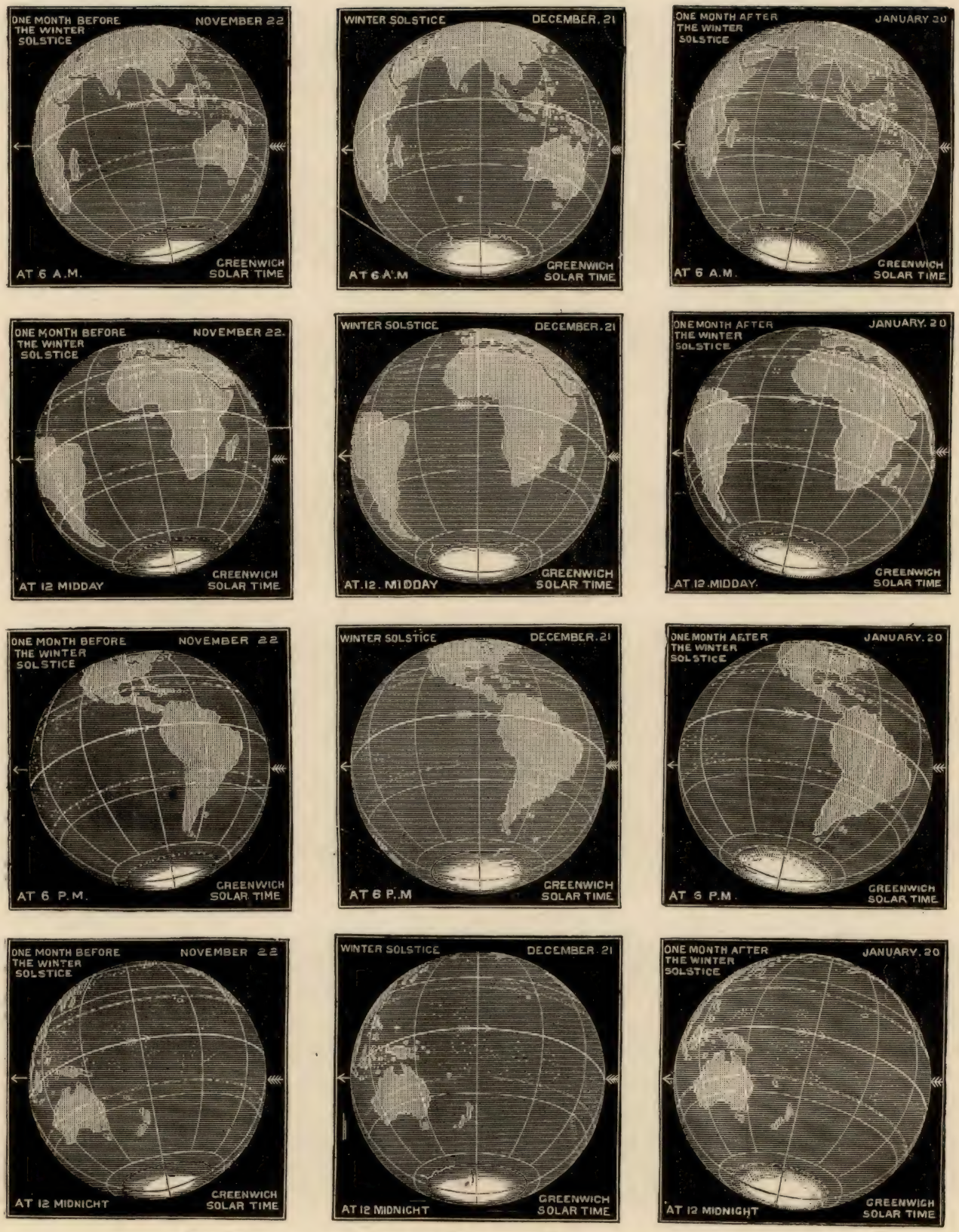
to the meridian at clock noon on or about June 14. This part of the loop is small because the westwardly range due to his slower motion across the meridians in the first part of the quarter is in part corrected by the balance of eastwardly range remaining until July 2 as the effect of more rapid motion in his orbit. In the latter part of the quarter more rapid motion athwart the meridians is corrected by slower motion along the orbit.

In the third quarter, from midsummer to autumn, we have similar effects,—a small range, because of the two causes acting in opposite directions. In the first part of the quarter the sun is moving more rapidly athwart the meridians, but more slowly in his orbit than the average, and there is only a slow eastwardly gain. So soon as he begins, at the middle of the quarter, to move more slowly across the meridians, his eastwardly gain is quickly worked off, both causes tending to reduce it, and he comes to the meridian again at clock noon about the end of August.

The rest of the sun's meridianal deviation corresponds to that in the first months of the year. He is at first moving more slowly athwart the meridians and also along his orbit, than the average; hence he passes rapidly westwards, losing ground through both causes. But during the last three months of the year he travels along his orbit more quickly than his average rate, and as during the last half of the quarter from autumn to winter he is also travelling more quickly athwart the meridians, he is brought by this excess of eastwardly motion to the meridian again at clock noon, by about Christmas Day.

The shape of the double loop on the meridian in Plate XXVII. corresponds with these movements. The westward side of the lower loop is larger than the eastward side, because there is a greater amount of eastwardly gain between the sun's passage of the winter solstice, and the time selected for setting the sun and clock together—about December 25—than there is between this time and the earth's passage of the perihelion.

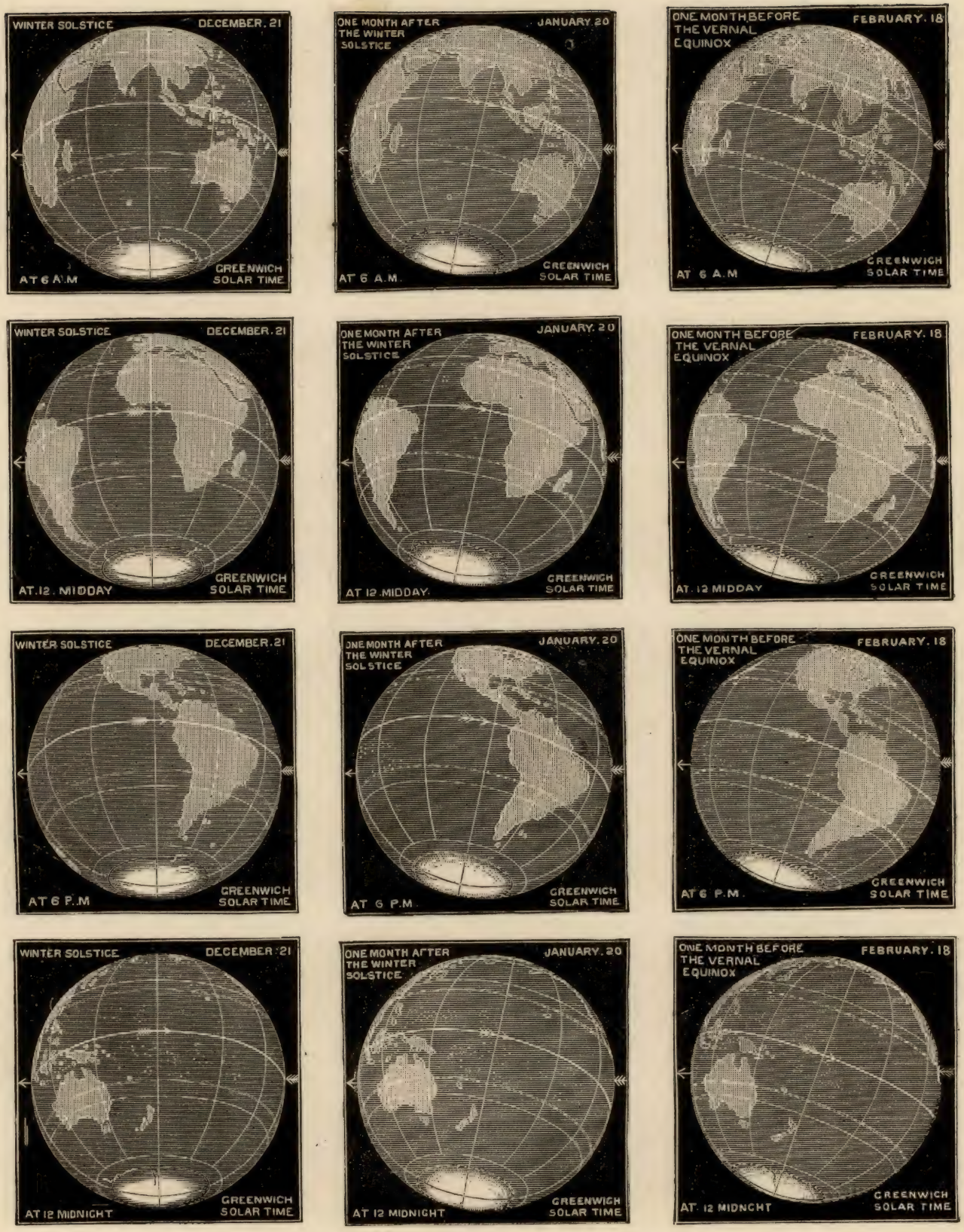
PLATE II.



Sun Views of the Earth in November, December, and January.

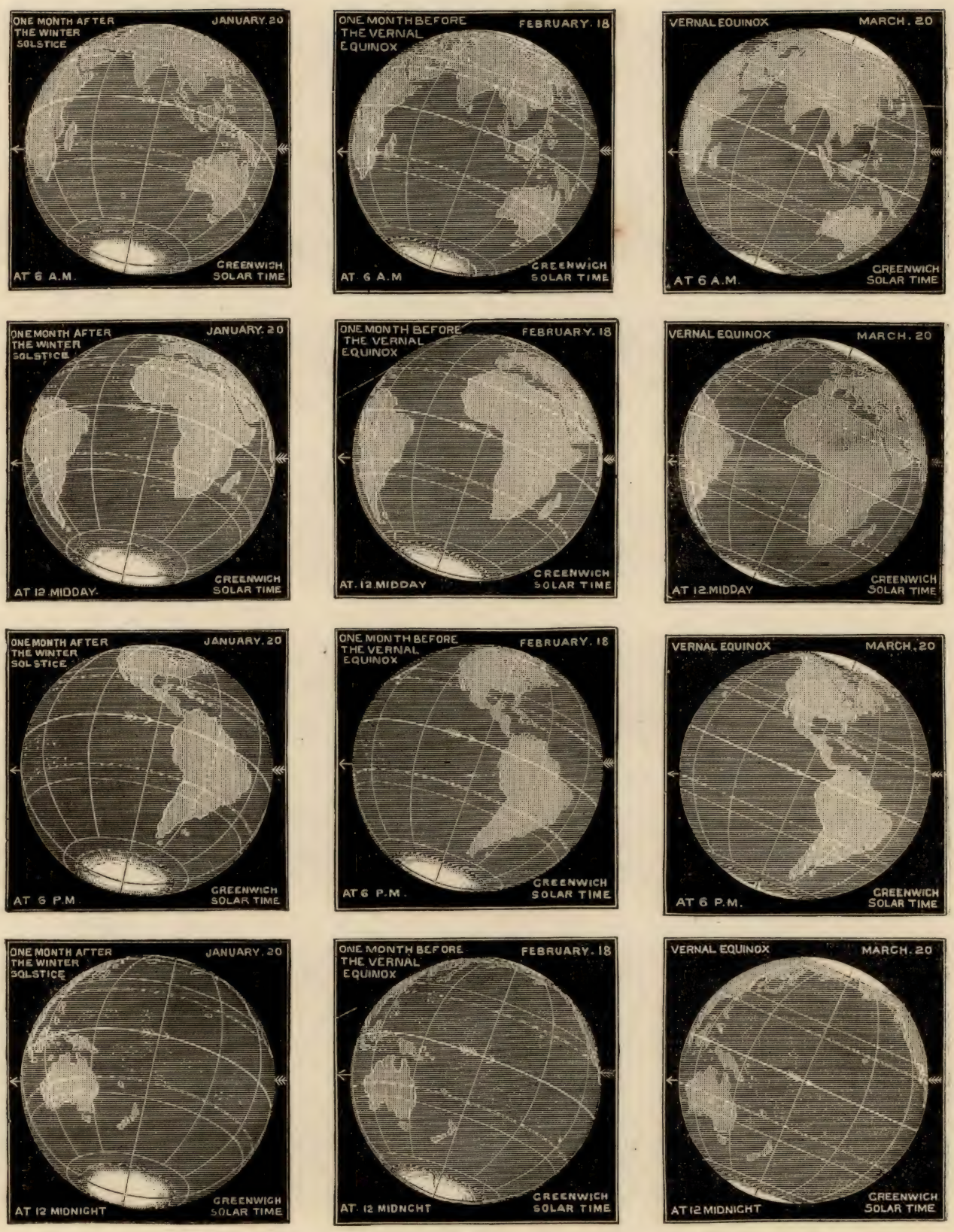
(*b*)

PLATE III.



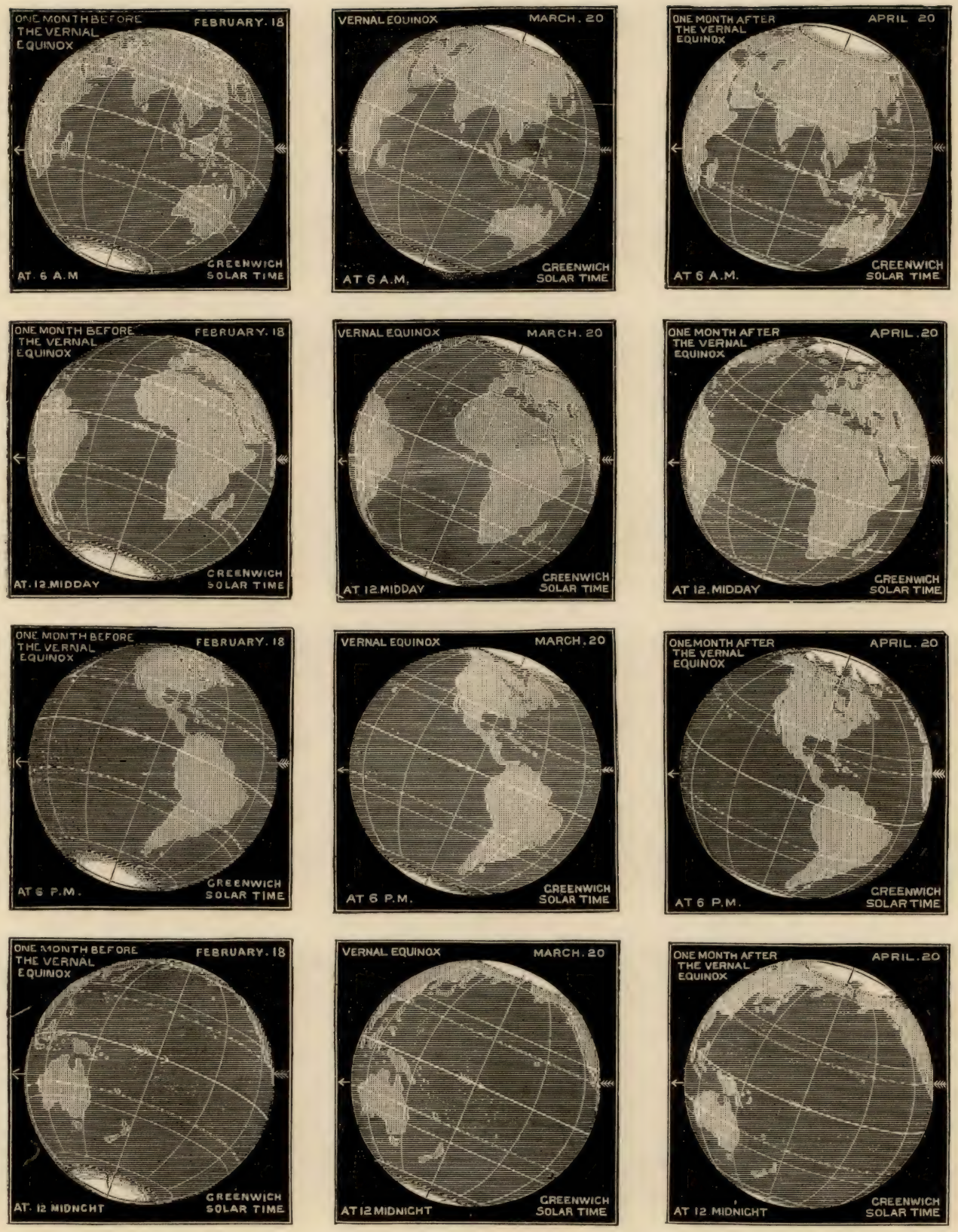
Sun Views of the Earth in December, January, and February.

PLATE IV.



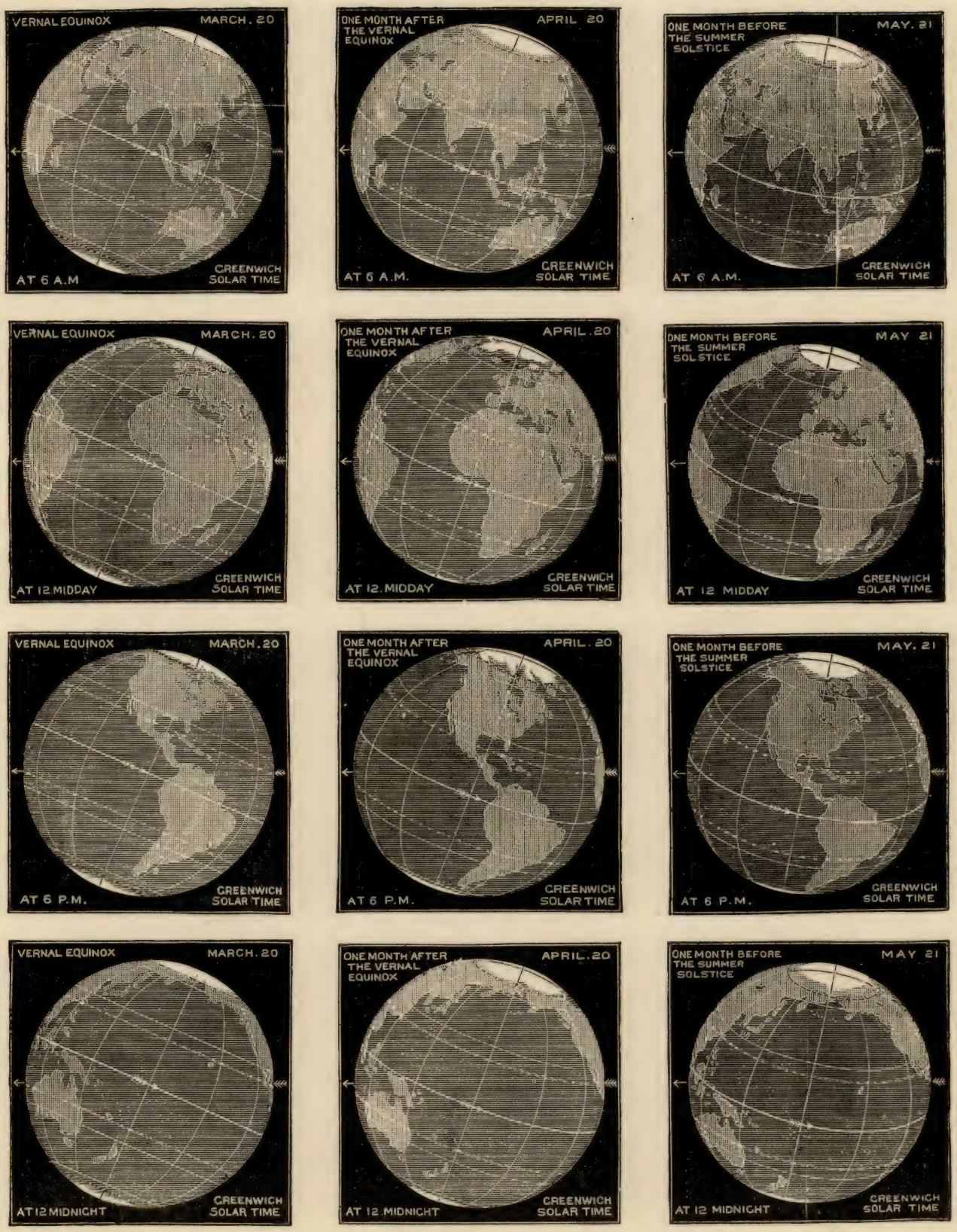
Sun Views of the Earth in January, February, and March.

PLATE V.



Sun Views of the Earth in February, March, and April.

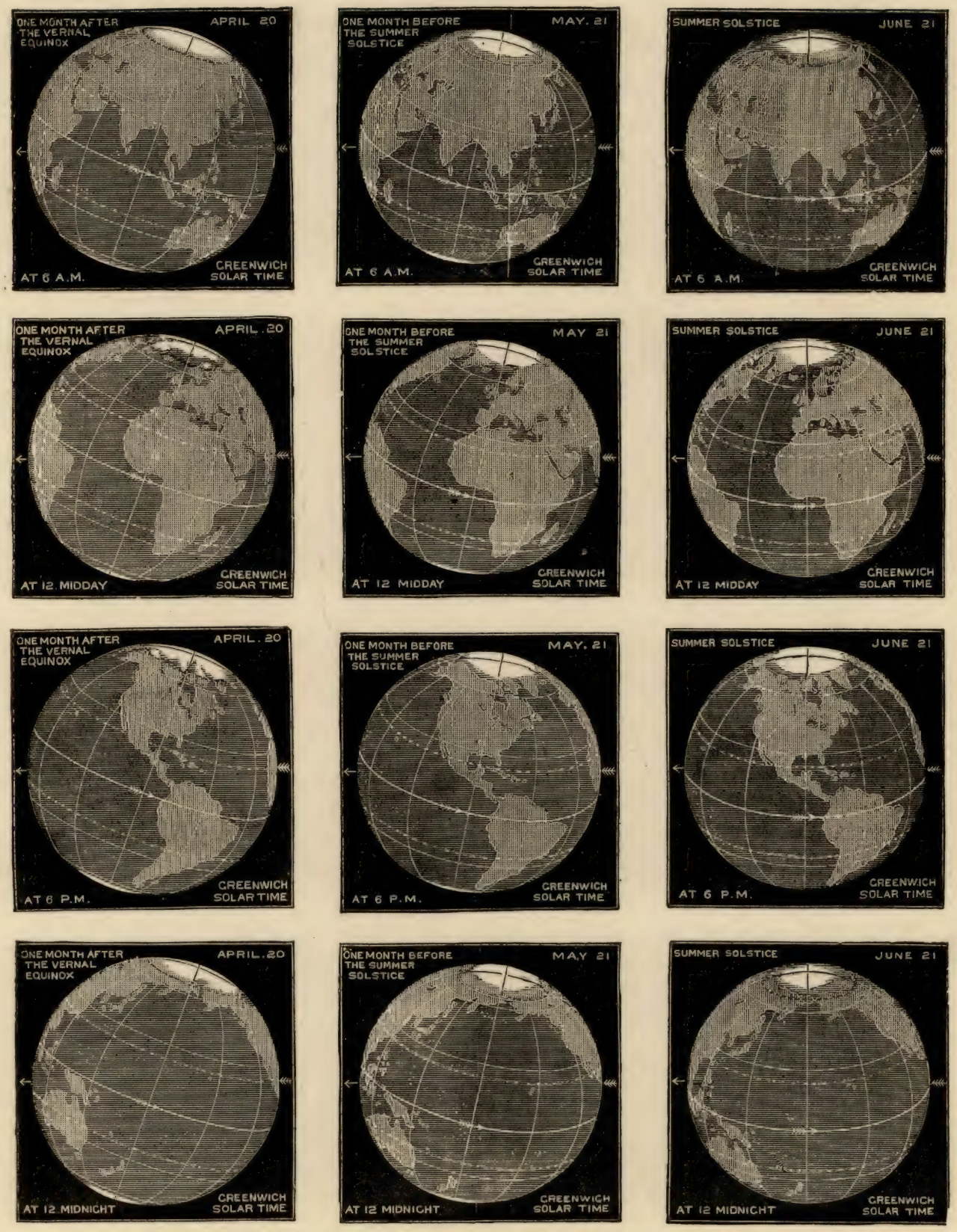
PLATE VI.



SUN VIEWS OF THE EARTH IN MARCH, APRIL, AND MAY.

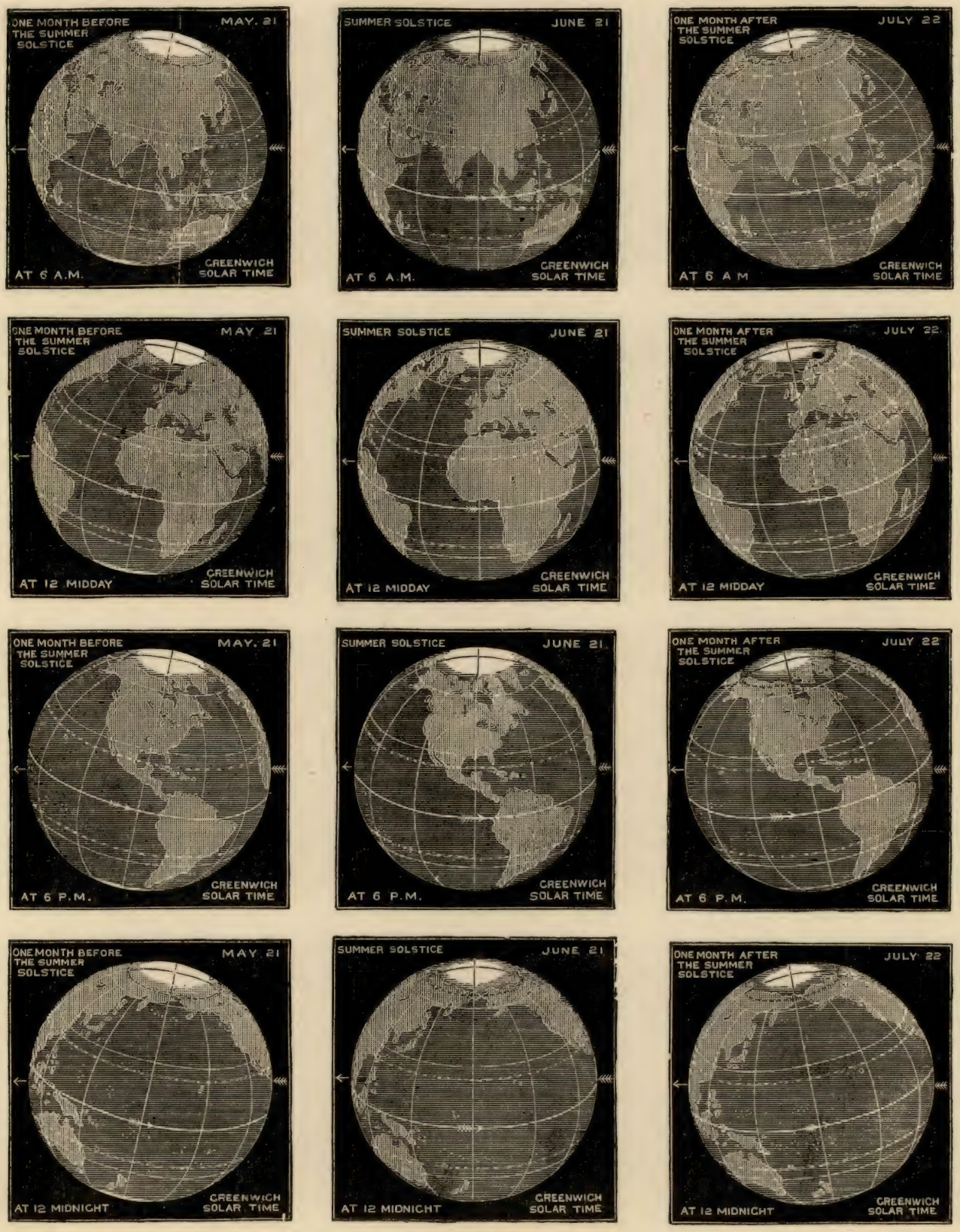
(*c*)

PLATE VII.



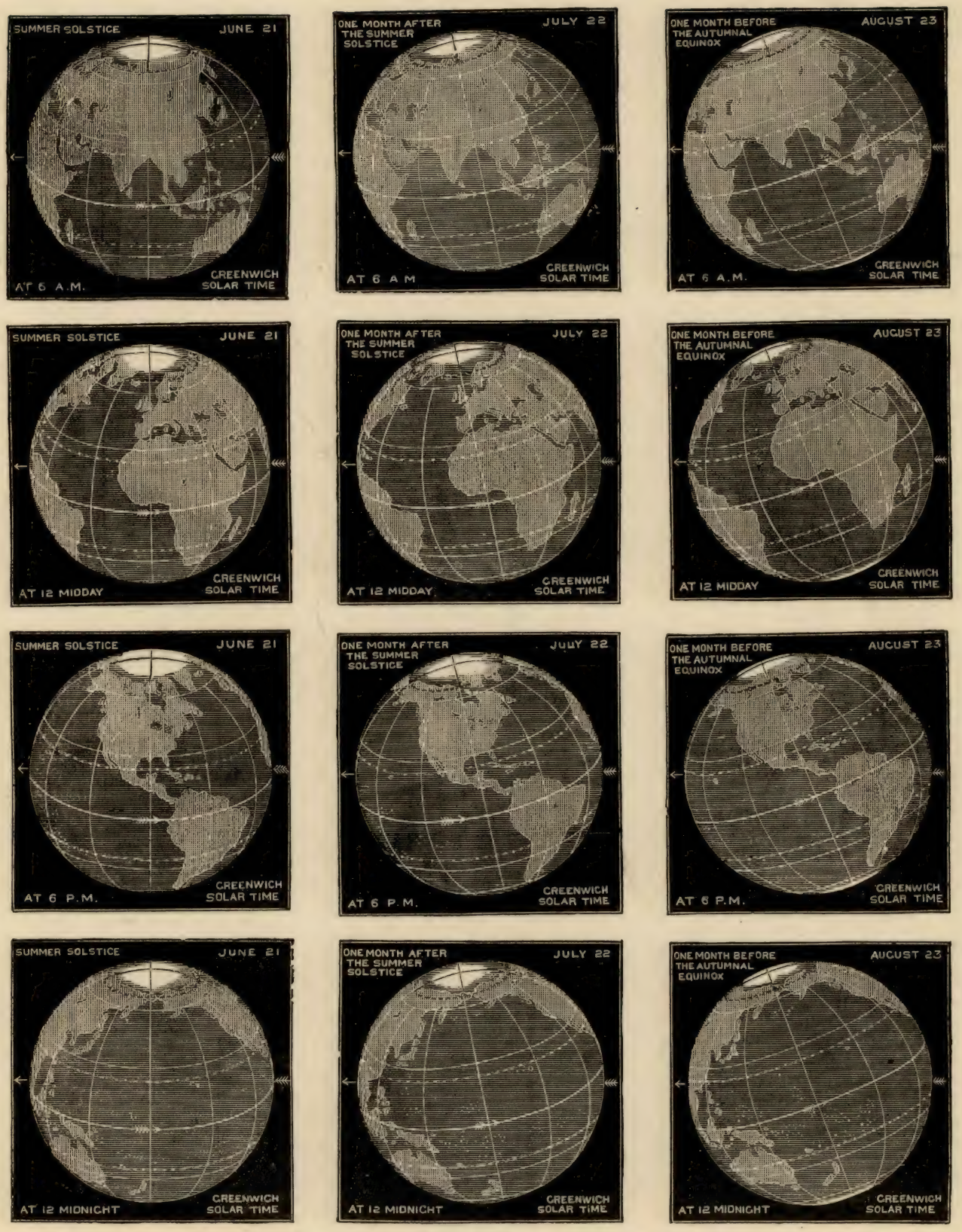
SUN VIEWS OF THE EARTH IN APRIL, MAY, AND JUNE.

PLATE VIII.



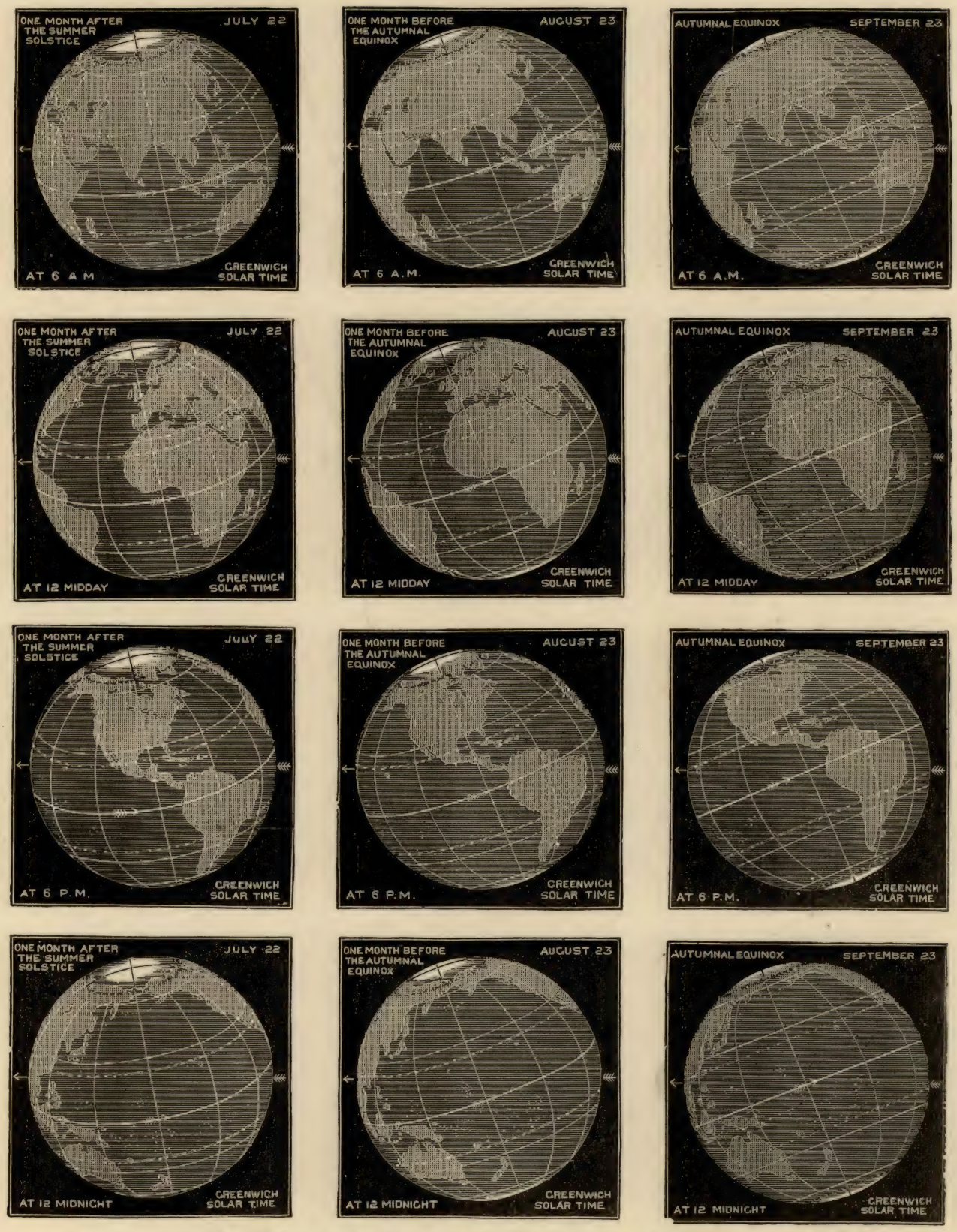
Sun Views of the Earth in May, June, and July

PLATE IX.



SUN VIEWS OF THE EARTH IN JUNE, JULY, AND AUGUST

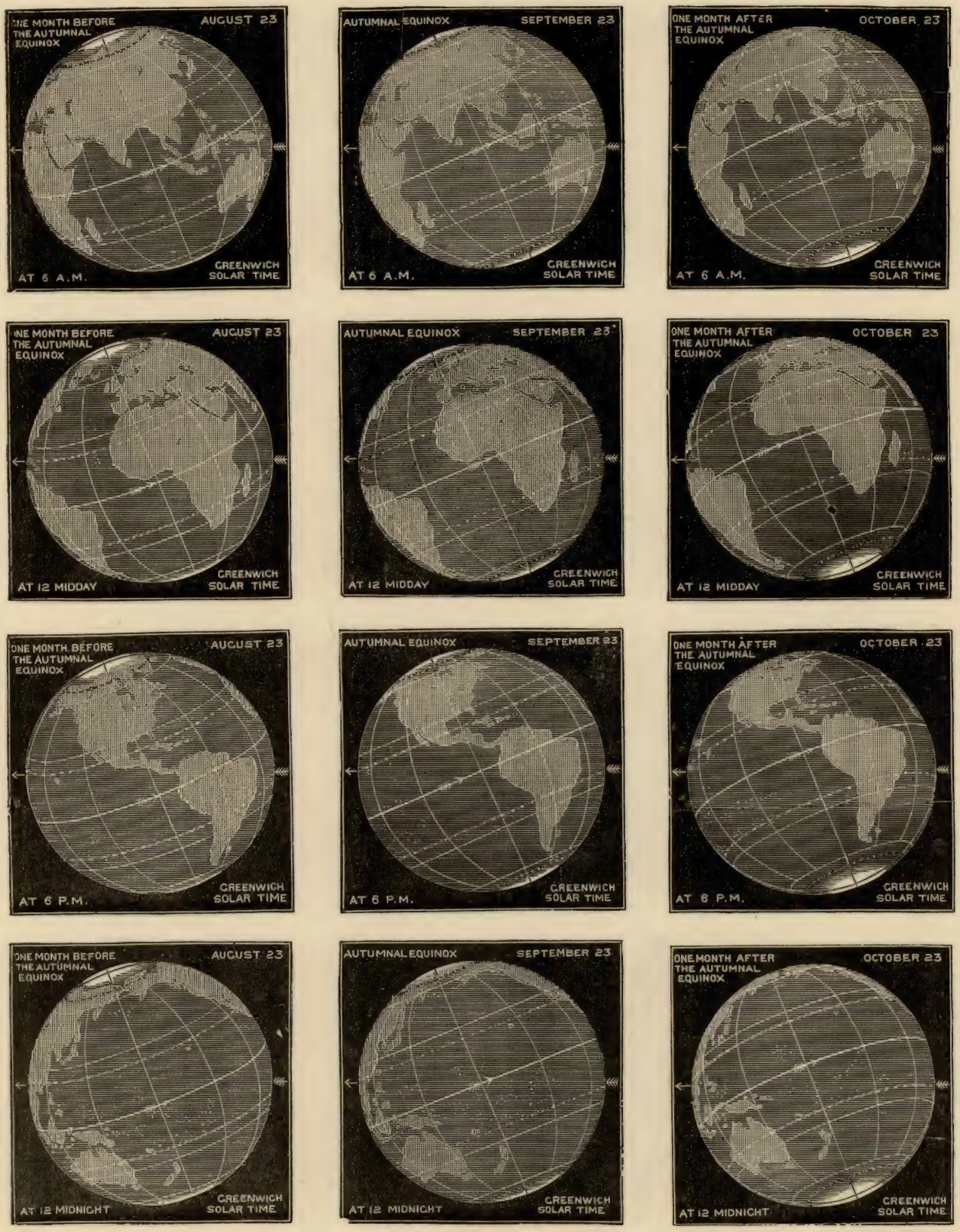
PLATE X.



SUN VIEWS OF THE EARTH IN JULY, AUGUST, AND SEPTEMBER.

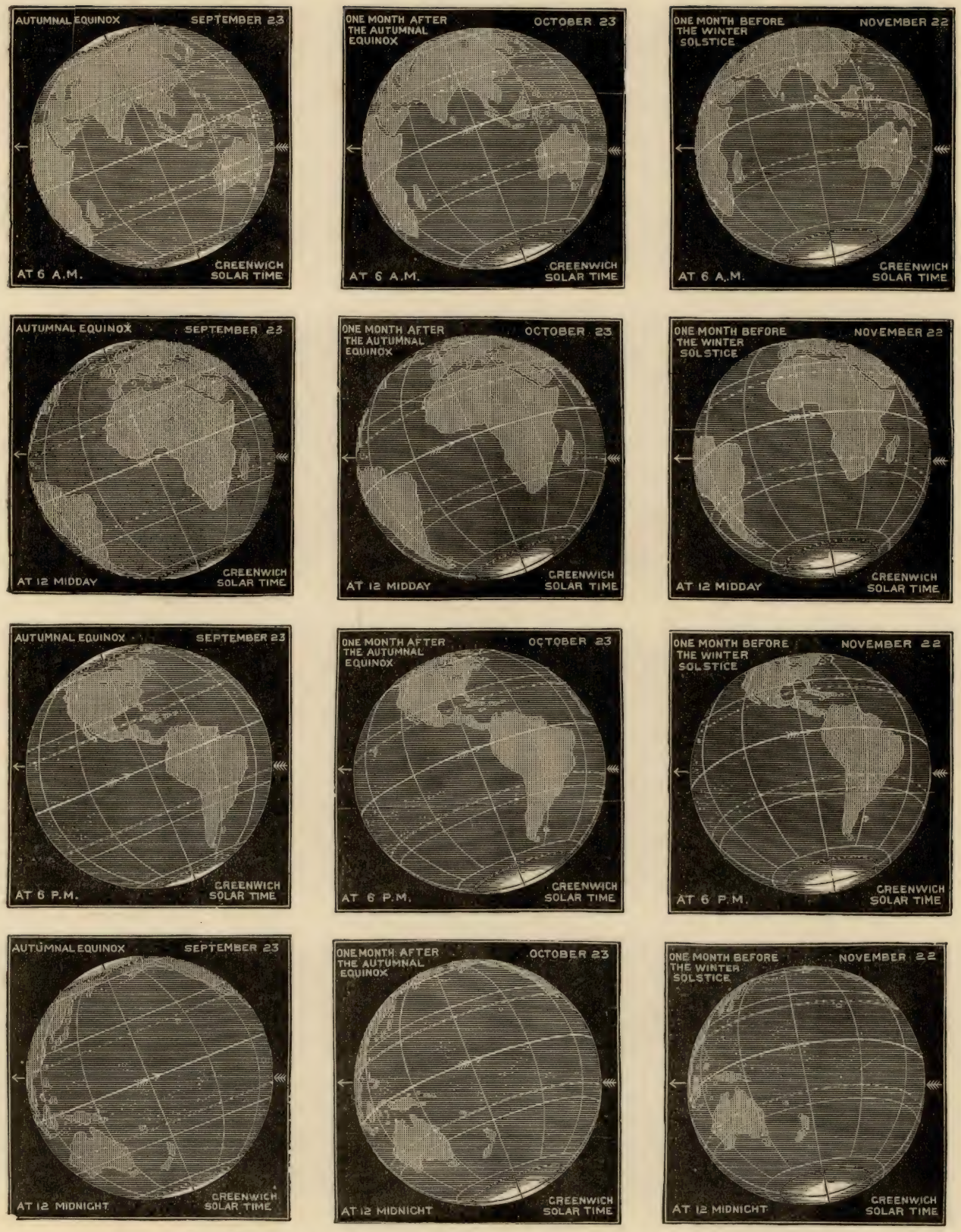
(*d*)

PLATE XI.



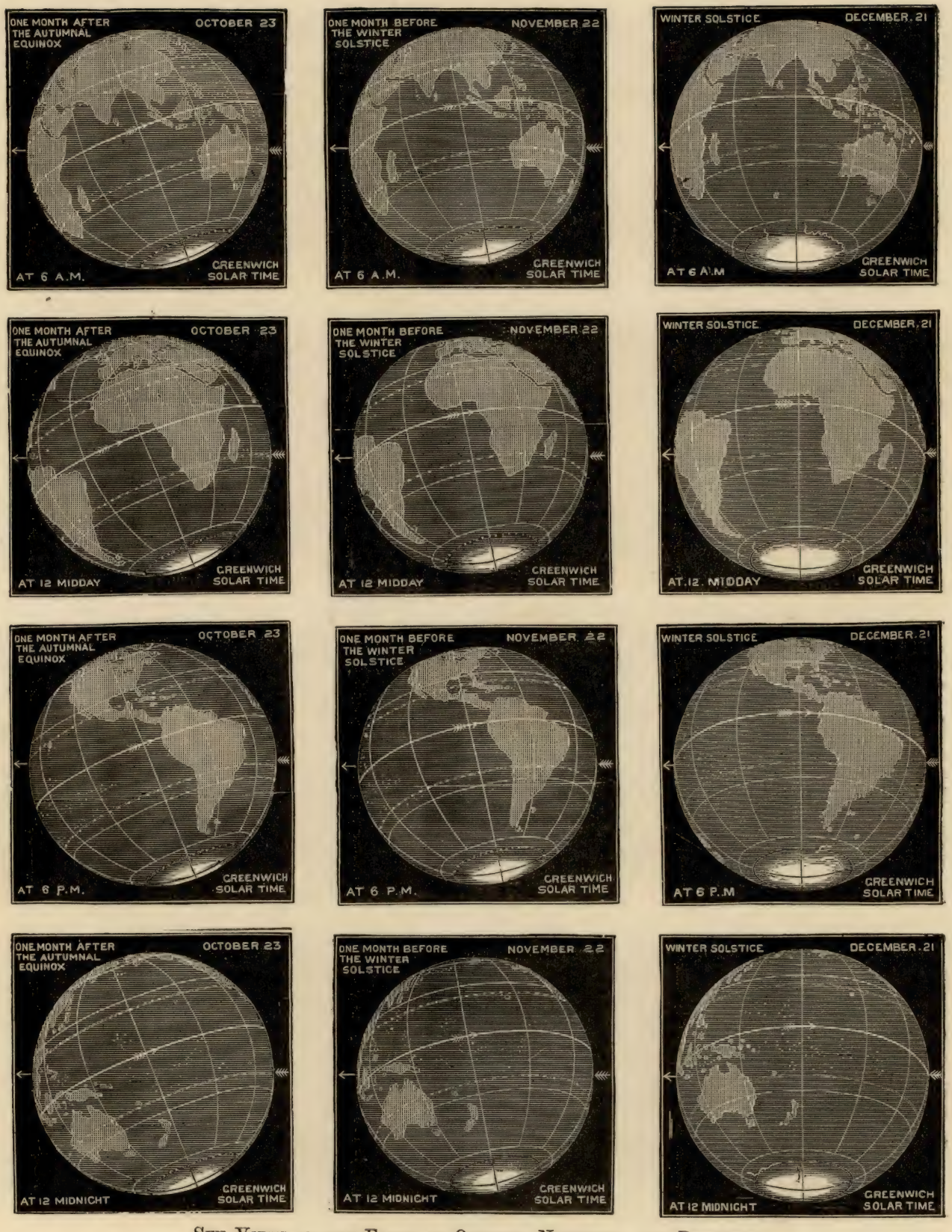
Sun Views of the Earth in August, September, and October.

PLATE XII.



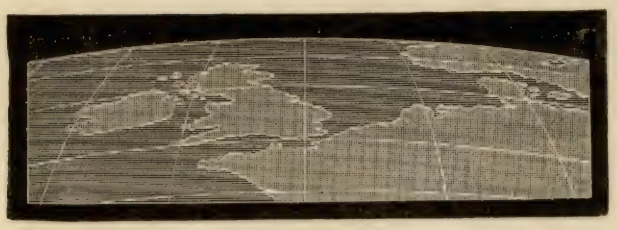
SUN VIEWS OF THE EARTH IN SEPTEMBER, OCTOBER, AND NOVEMBER.

PLATE XIII.



SUN VIEWS OF THE EARTH IN OCTOBER, NOVEMBER, AND DECEMBER.

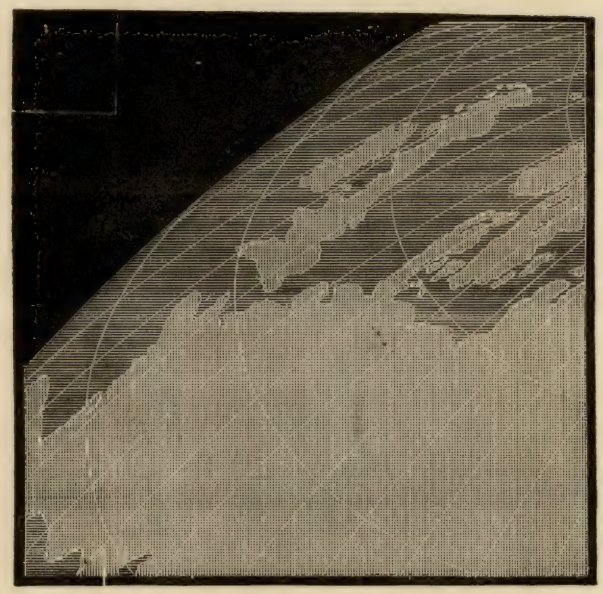
PLATE XIV.—SUN VIEWS OF THE BRITISH ISLES, FRANCE, DENMARK, &c.



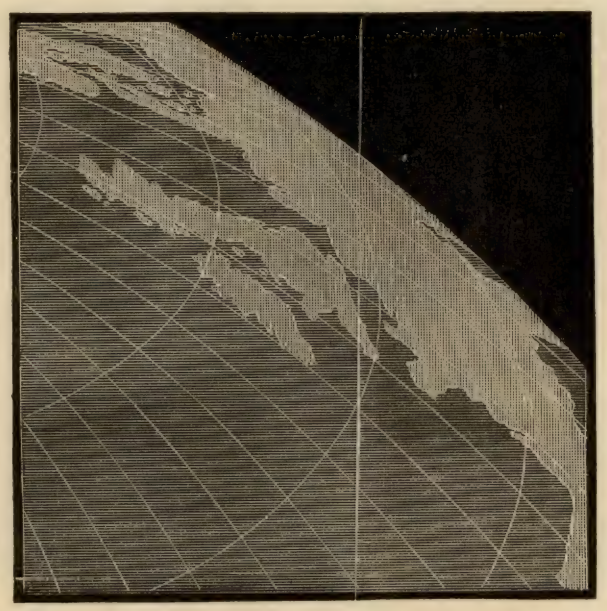
At noon, Midwinter (Greenwich time).

At noon, in Spring or Autumn (Greenwich time).

At noon, Midsummer (Greenwich time).

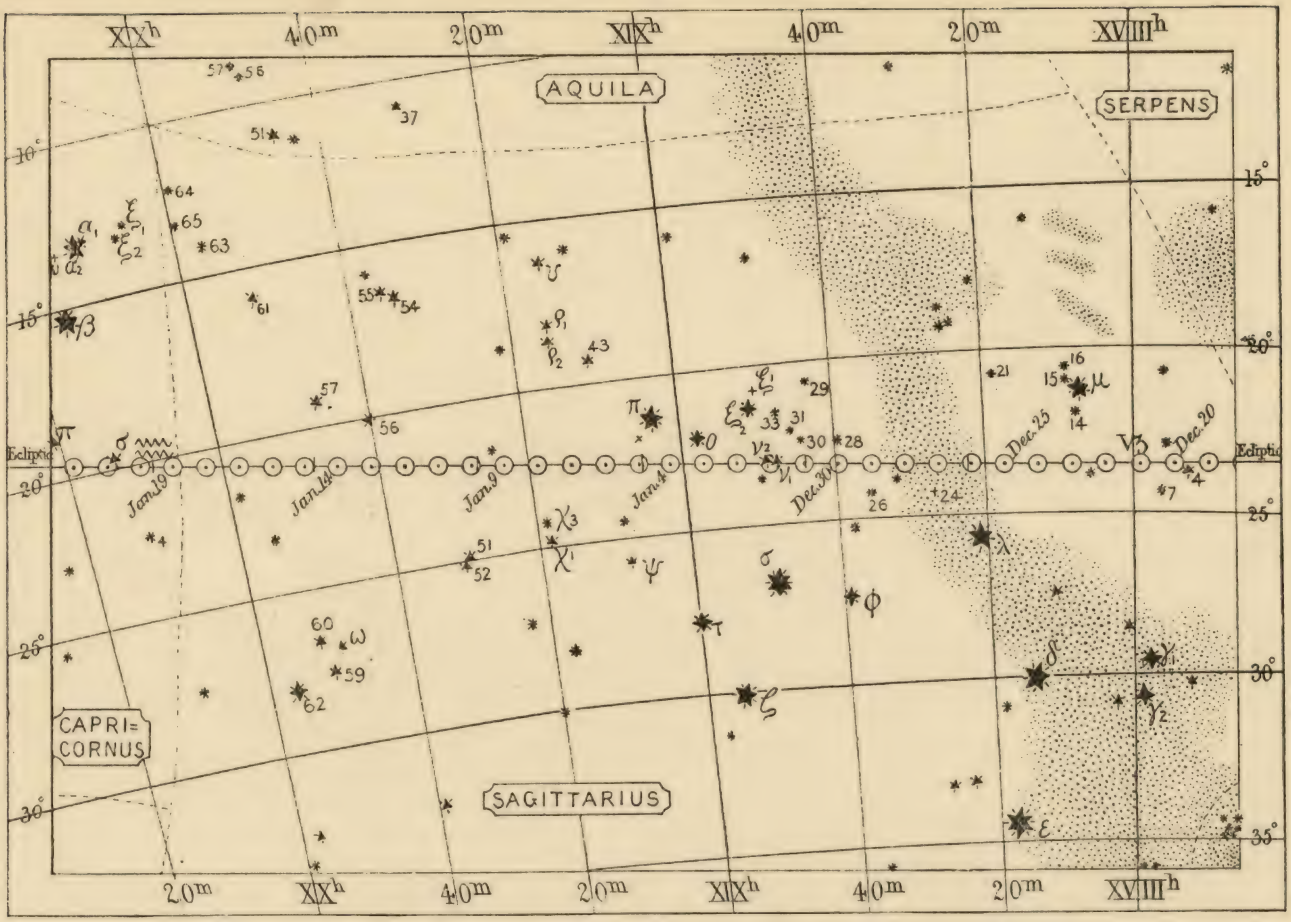


At six in the morning, Midsummer.

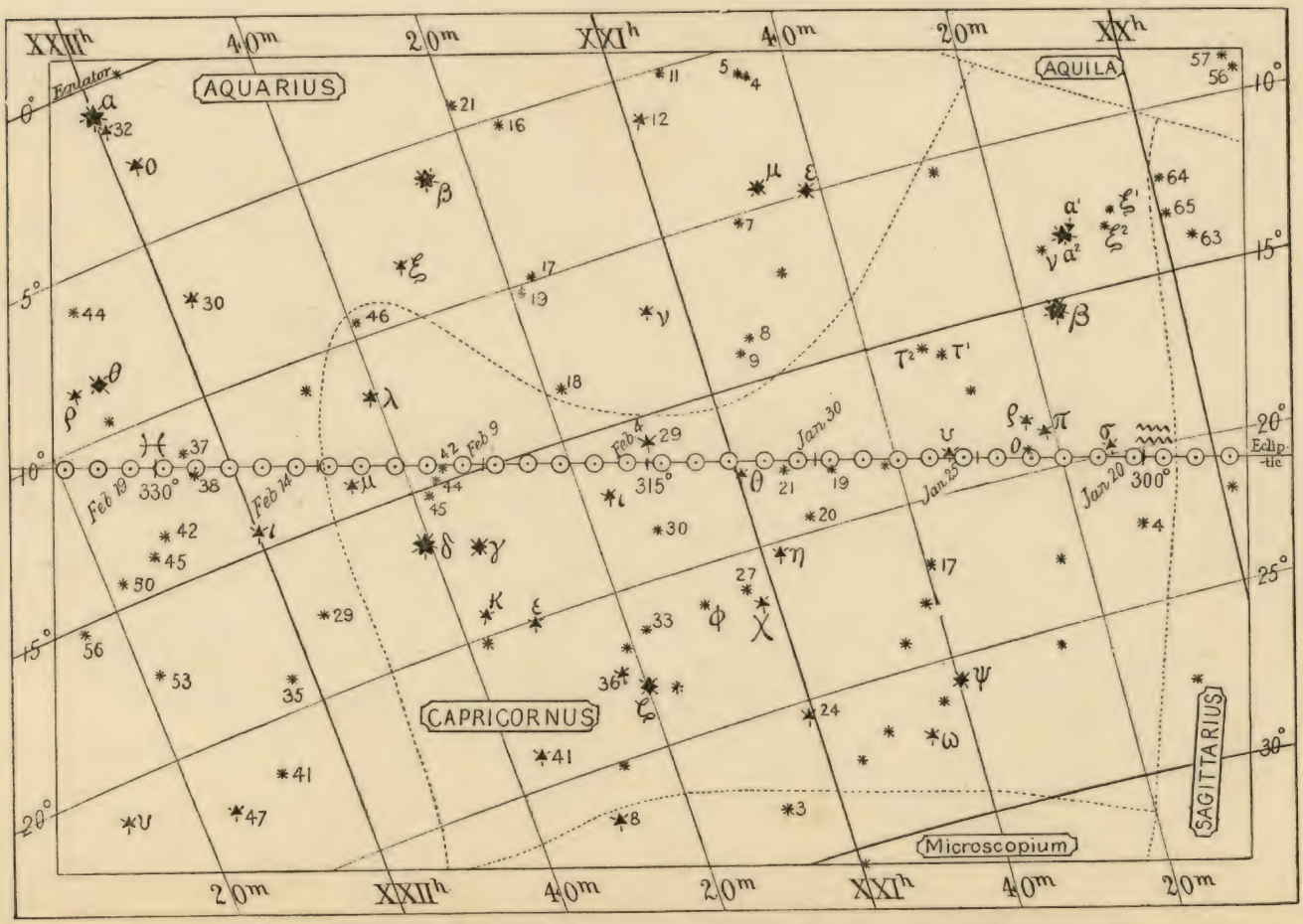


At six in the evening, Midsummer.

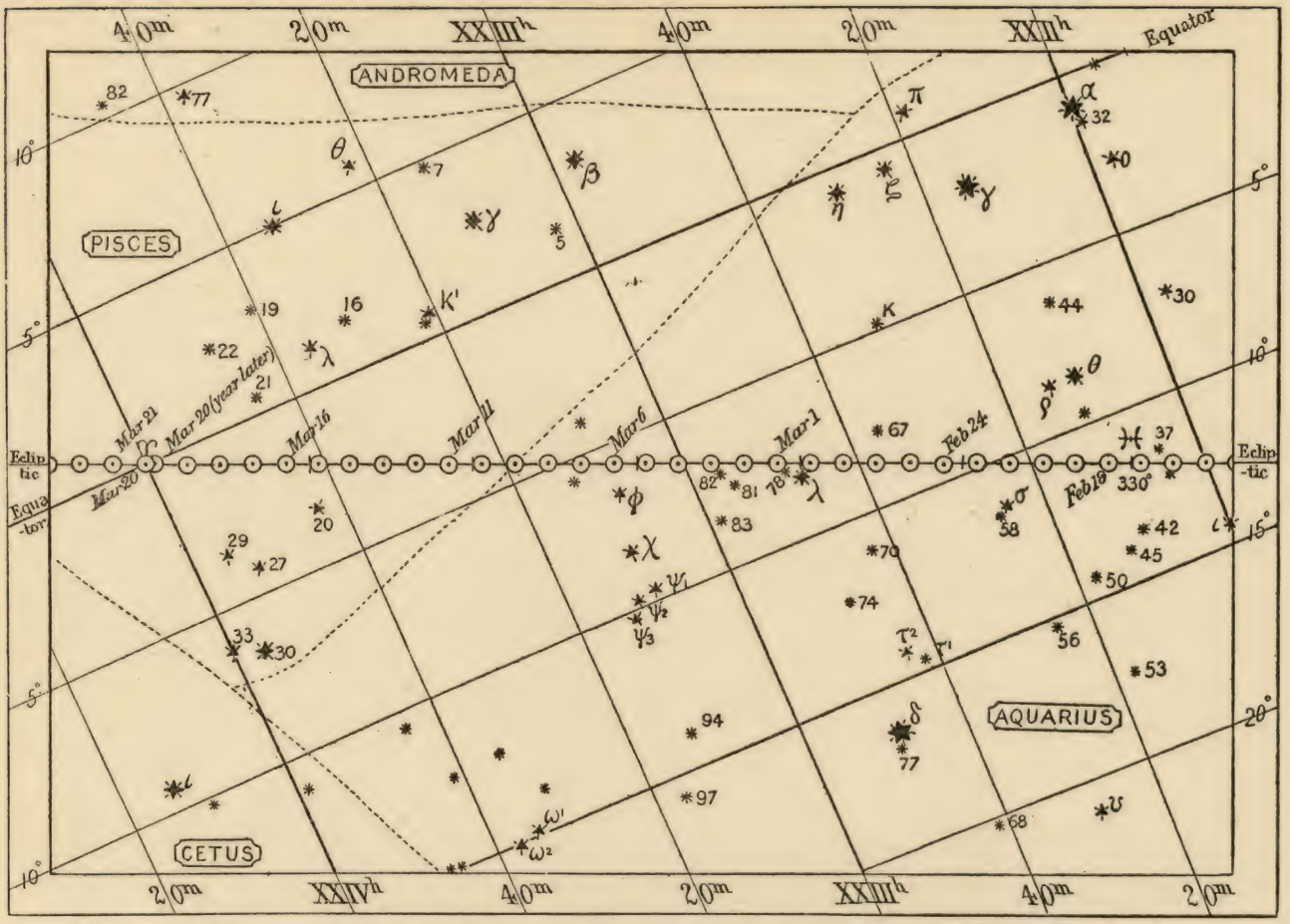
e)



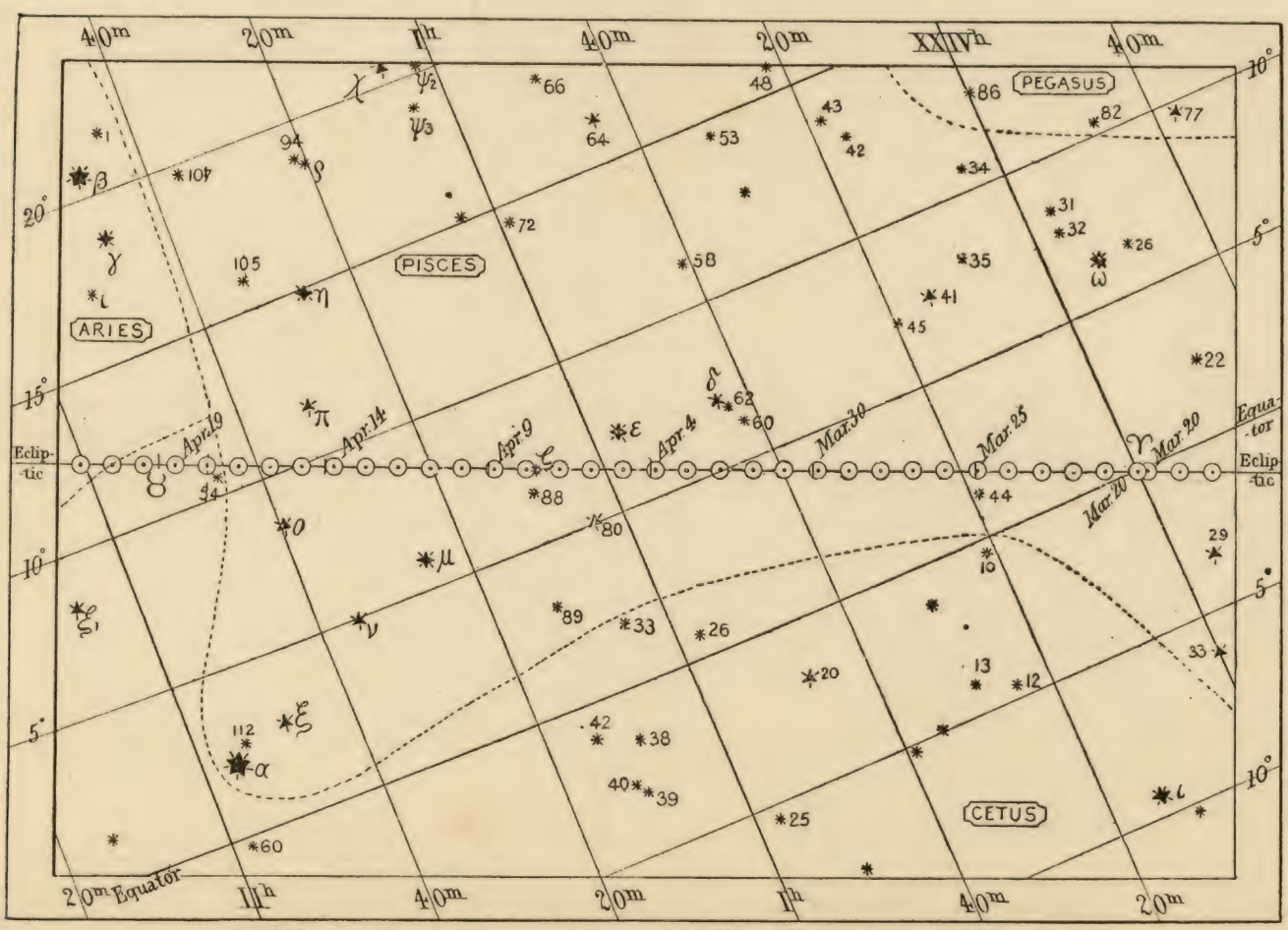
1.—The Sun's course through the sign Capricornus (Constellation Sagittarius).



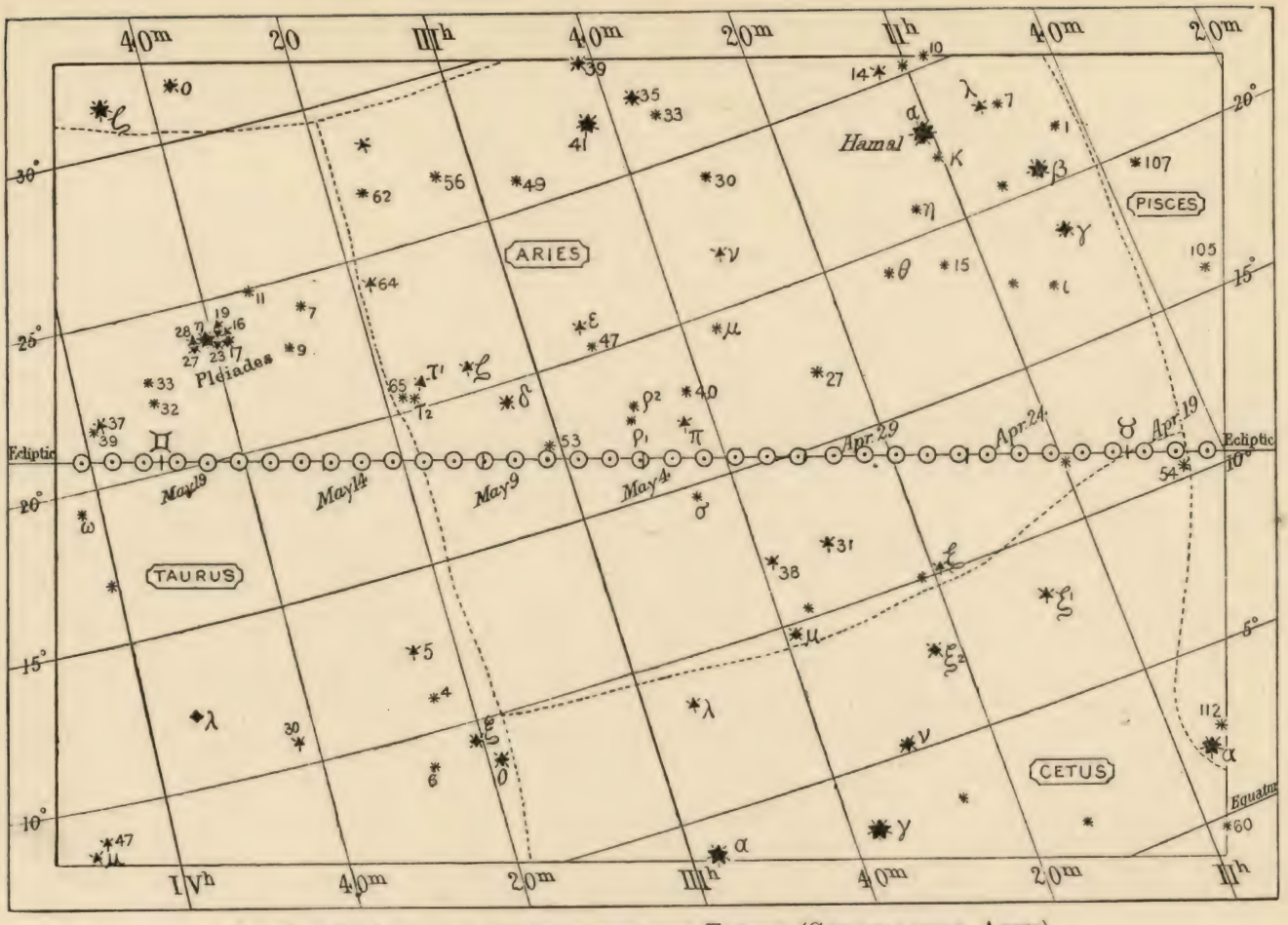
2.—The Sun's course through the sign Aquarius (Constellation Capricornus).



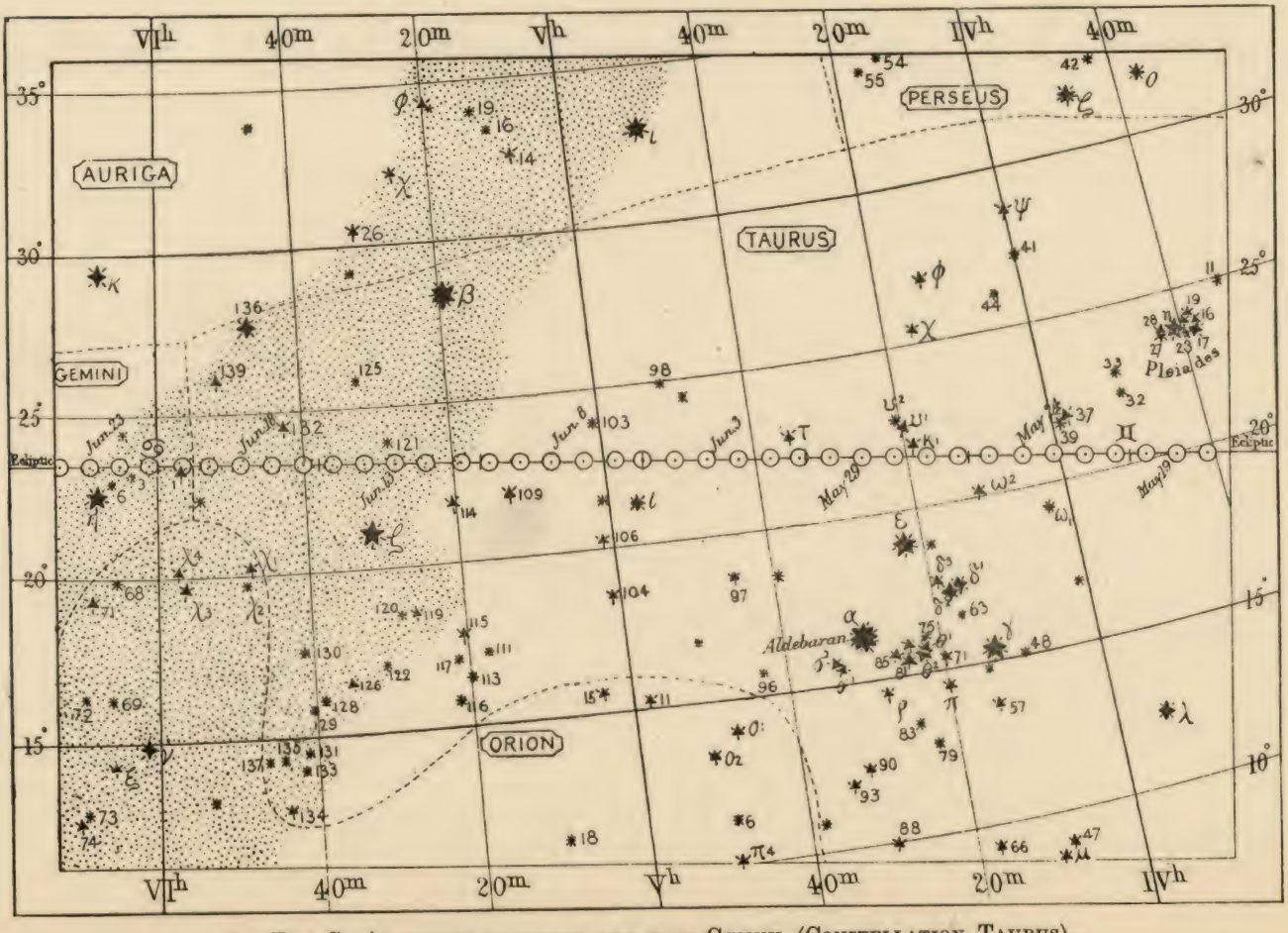
3.—The Sun's course through the sign Pisces (Constellation Aquarius).



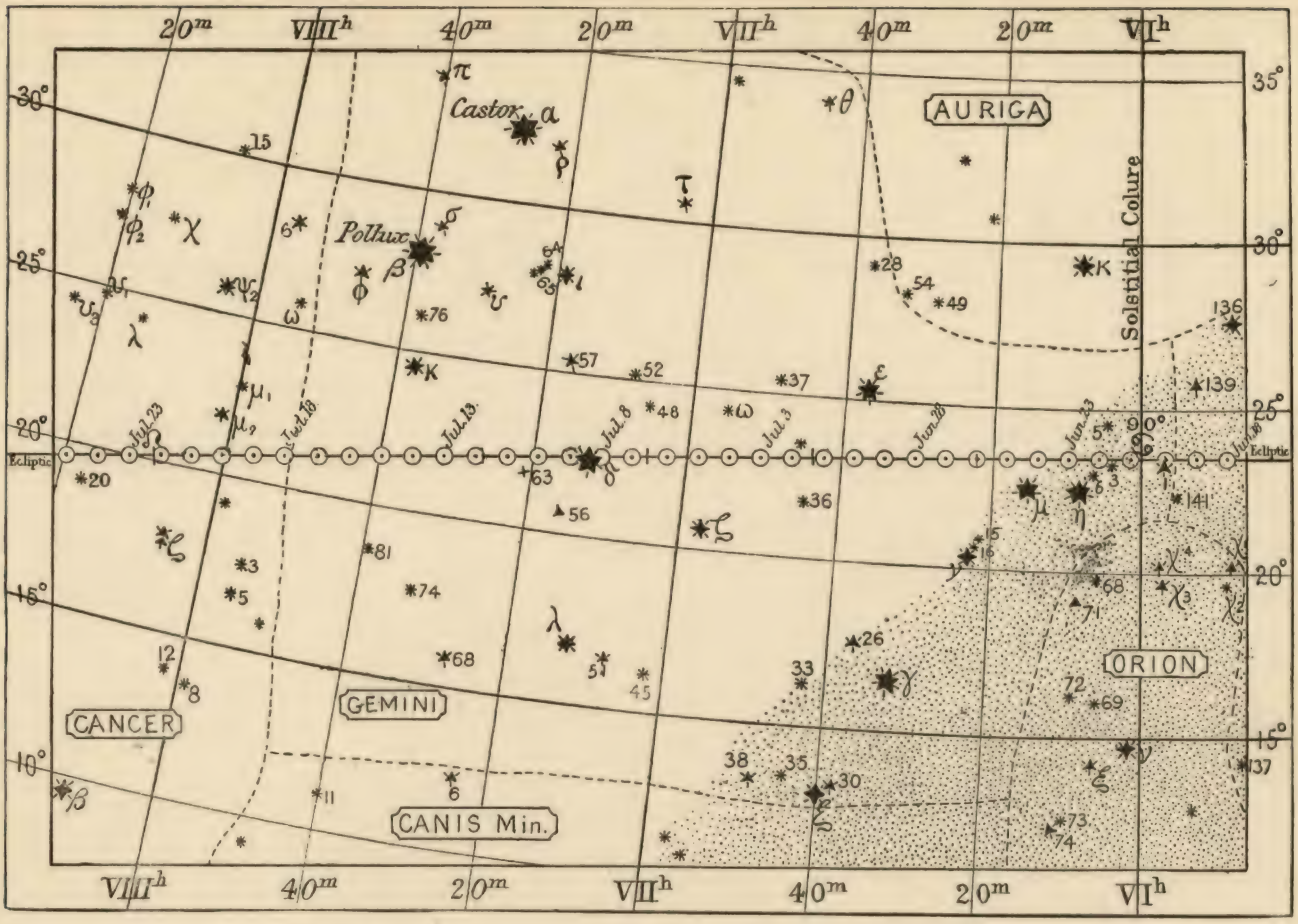
4.—The Sun's course through the sign Aries (Constellation Pisces).



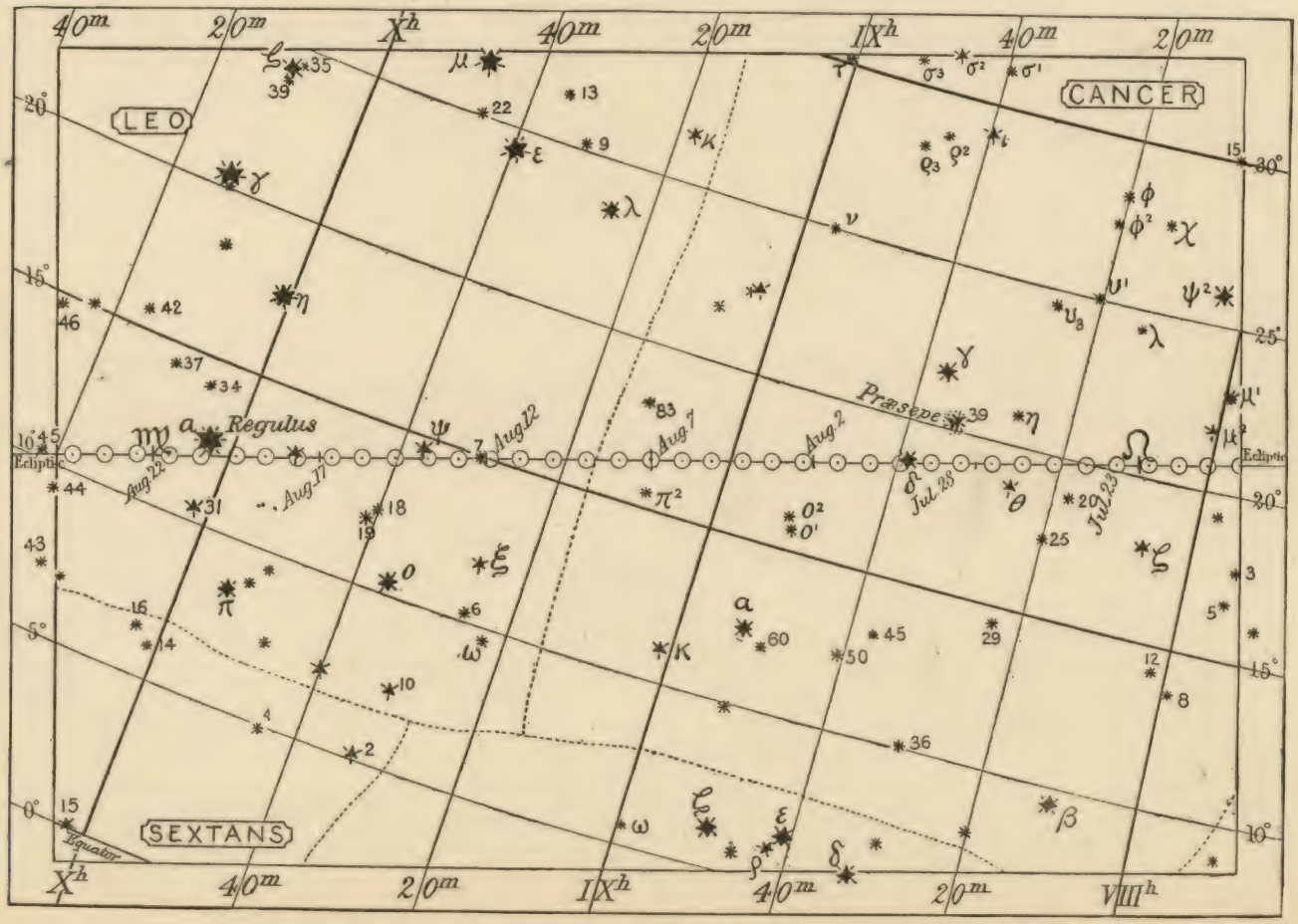
5.—The Sun's course through the sign Taurus (Constellation Aries).



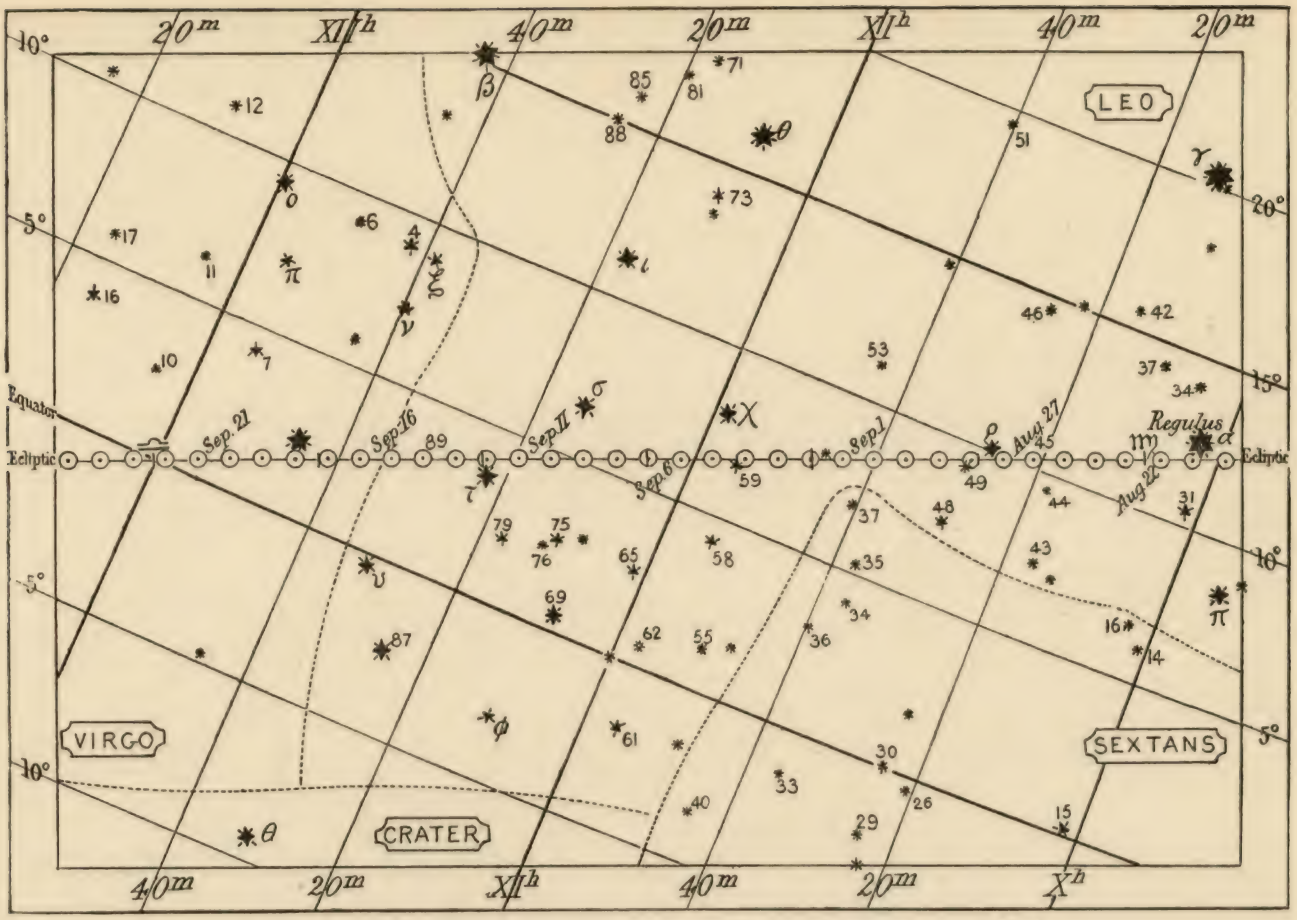
6.—The Sun's course through the sign Gemini (Constellation Taurus).



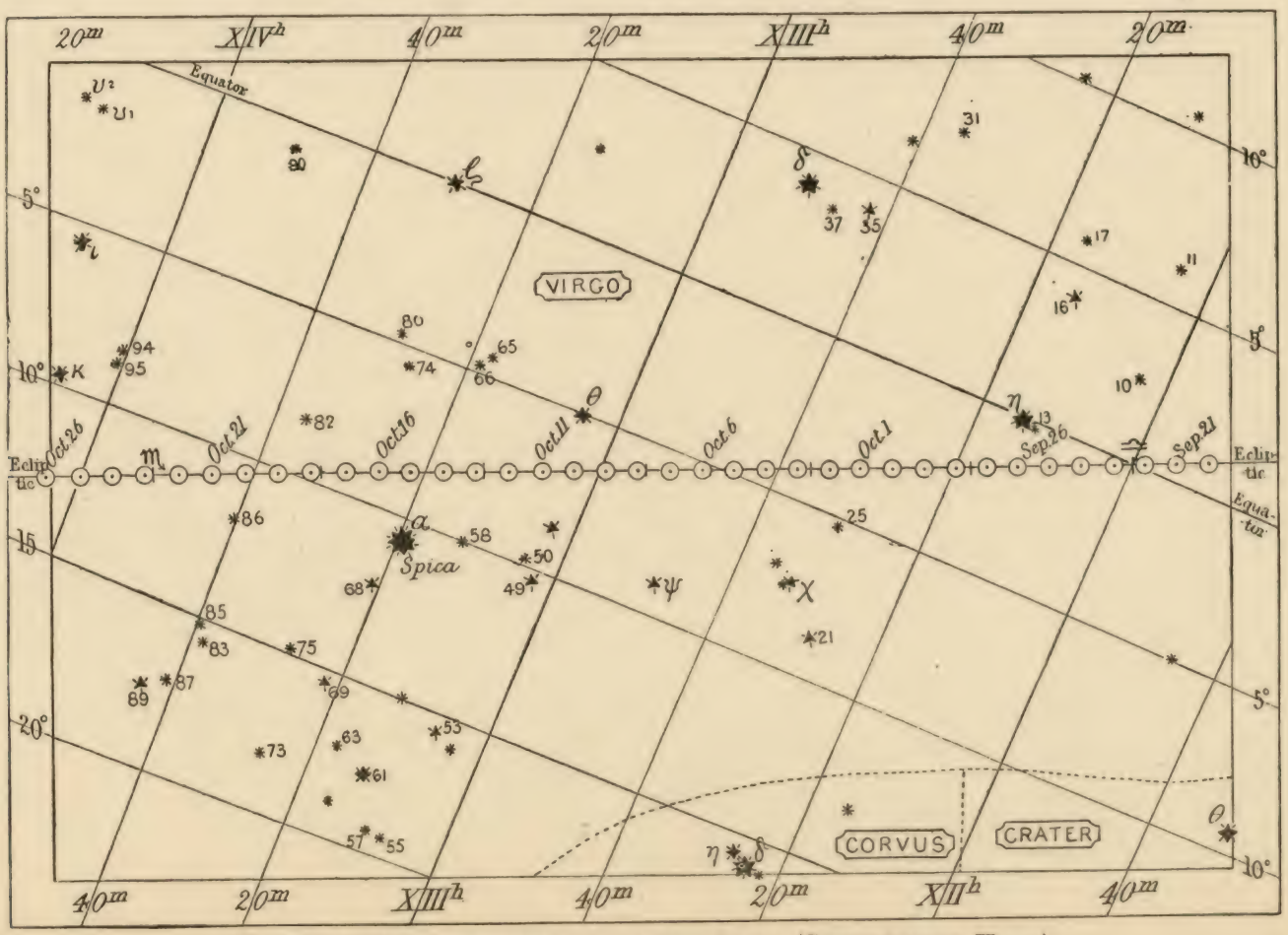
7.—The Sun's course through the sign Cancer (Constellation Gemini).



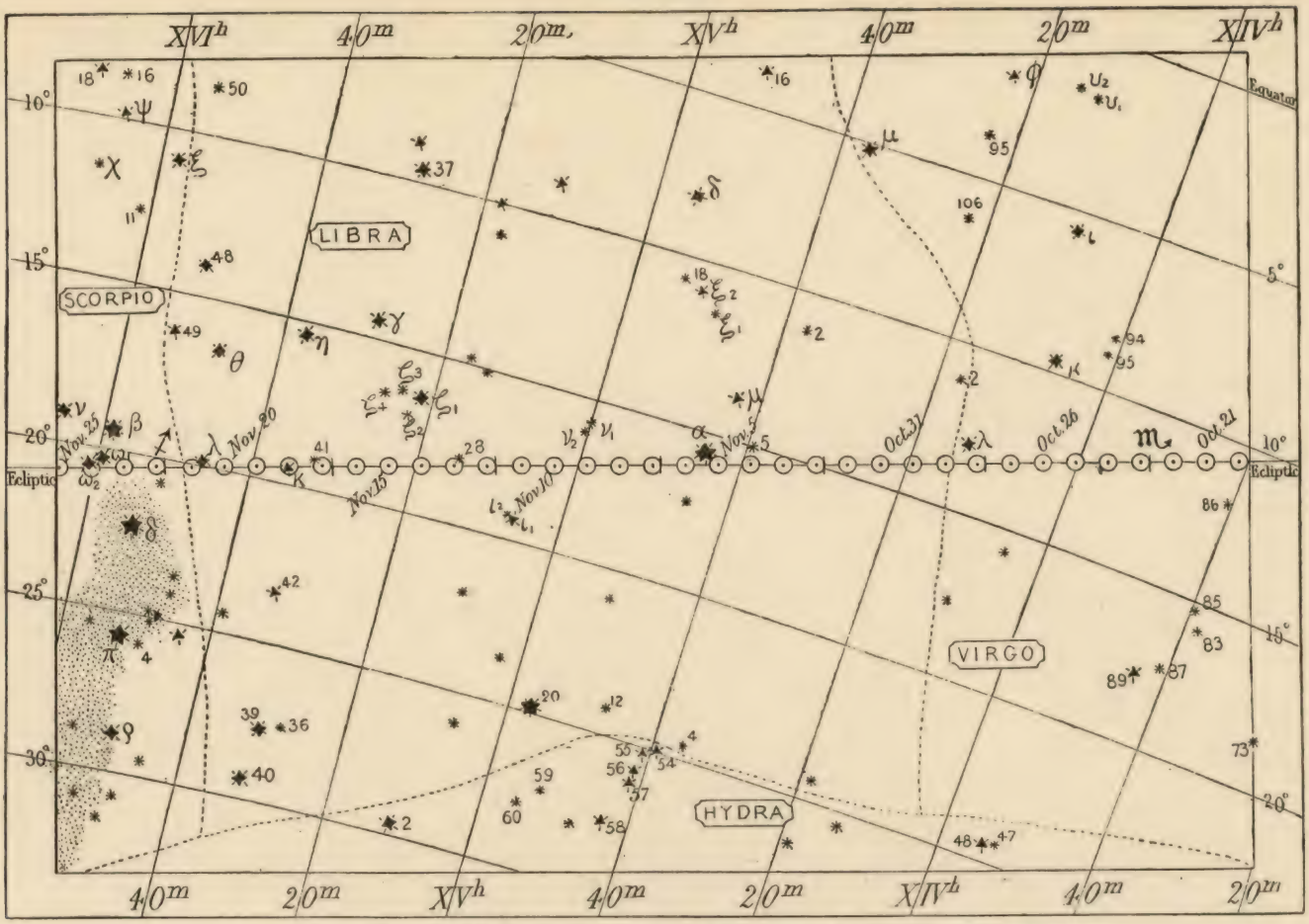
8.—The Sun's course through the sign Leo (Constellation Cancer). (*f*)



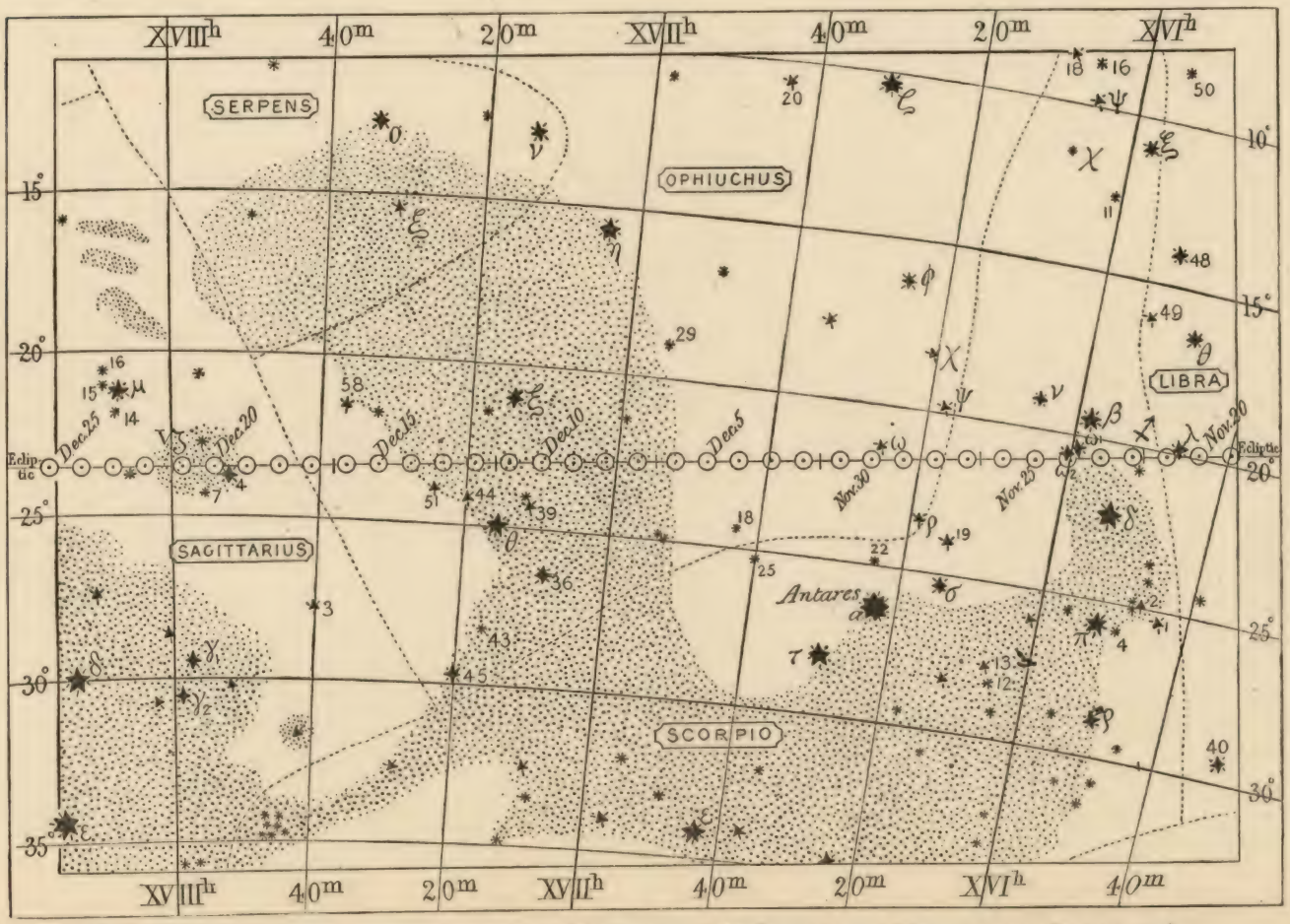
9.—The Sun's course through the sign Virgo (Constellation Leo).



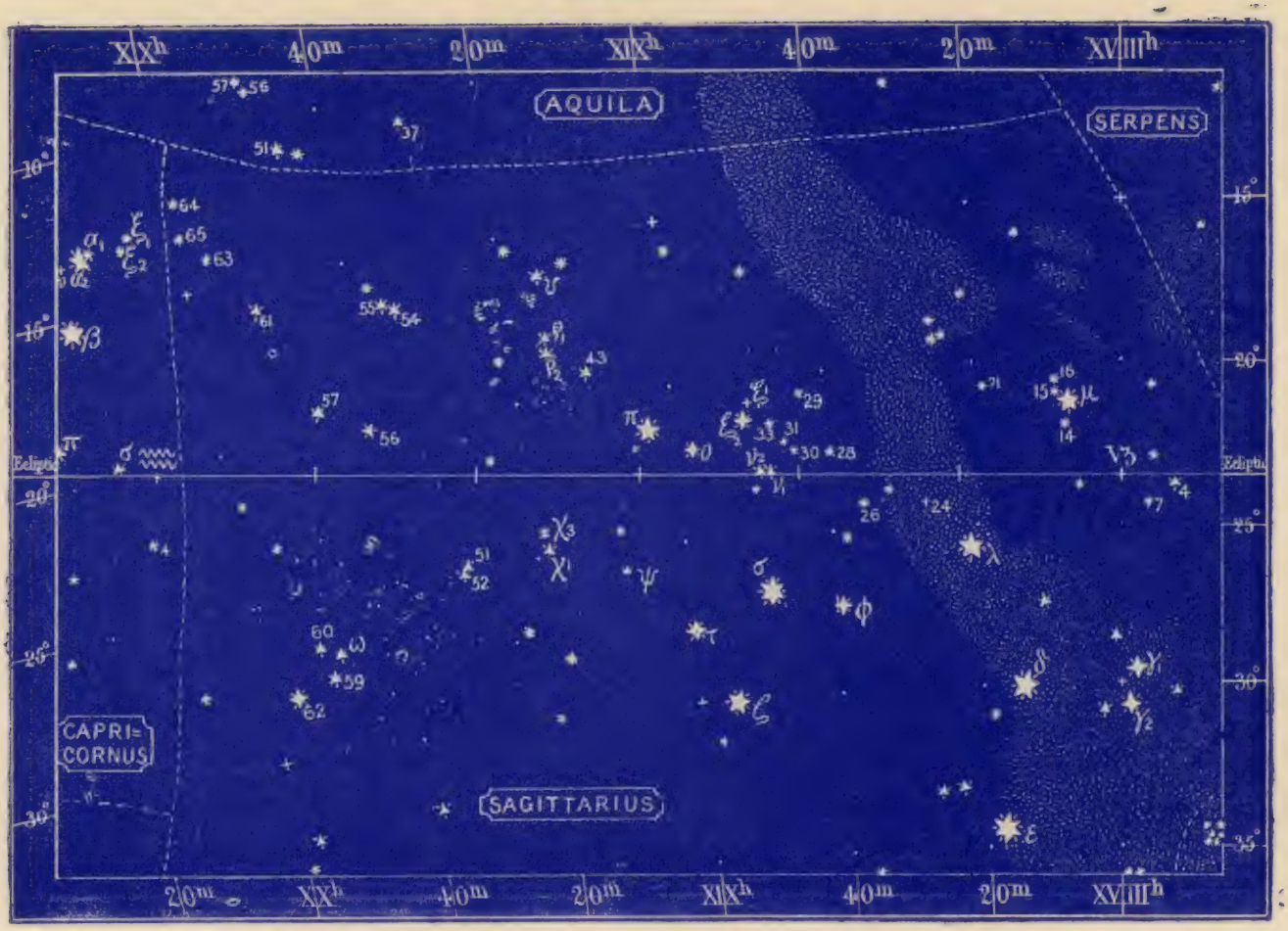
10.—The Sun's course through the sign Libra (Constellation Virgo).



11.—The Sun's course through the sign Scorpio (Constellation Libra).

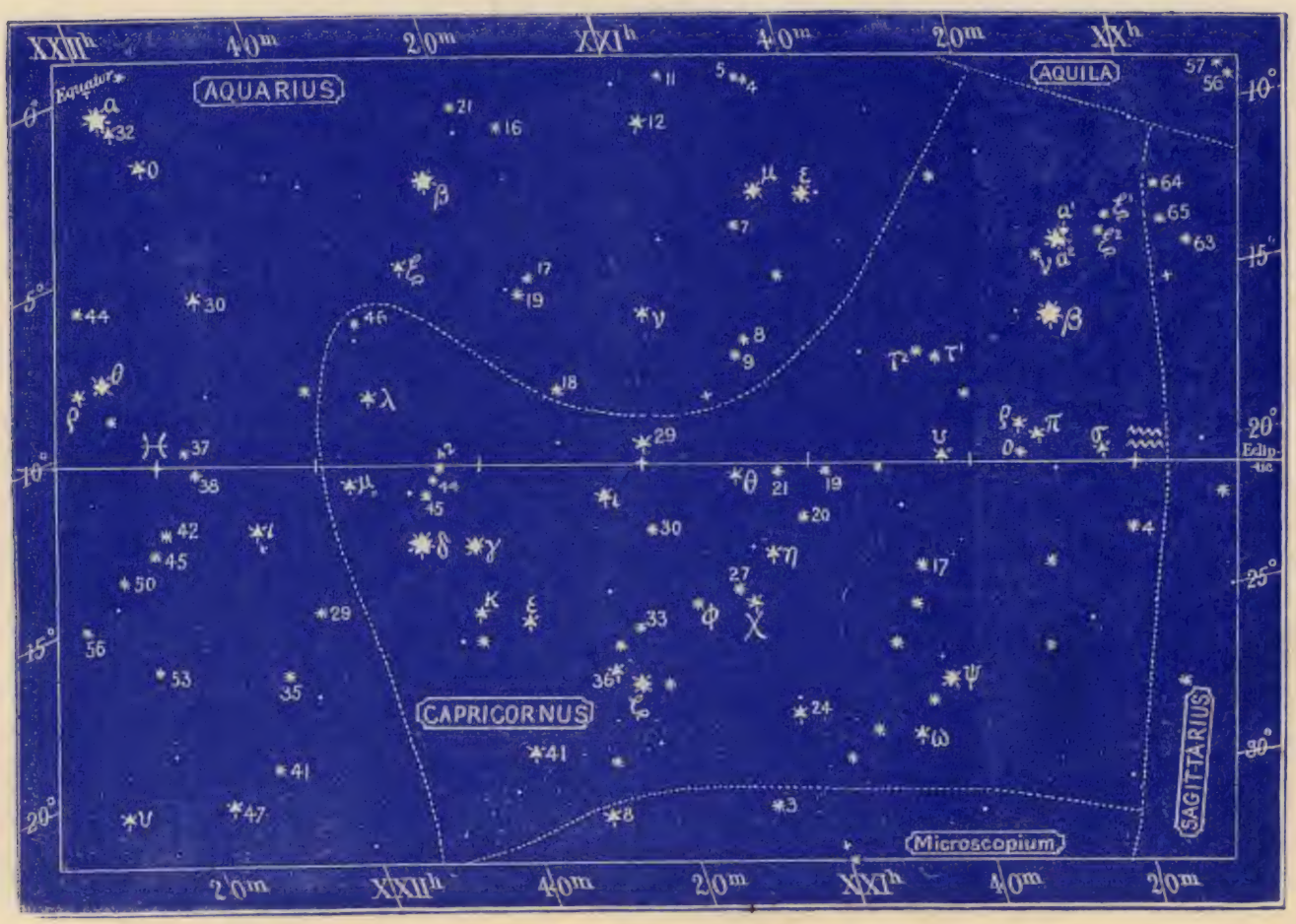


12.—The Sun's course through the sign Sagittarius (Constellation Scorpio and Ophiuchus).



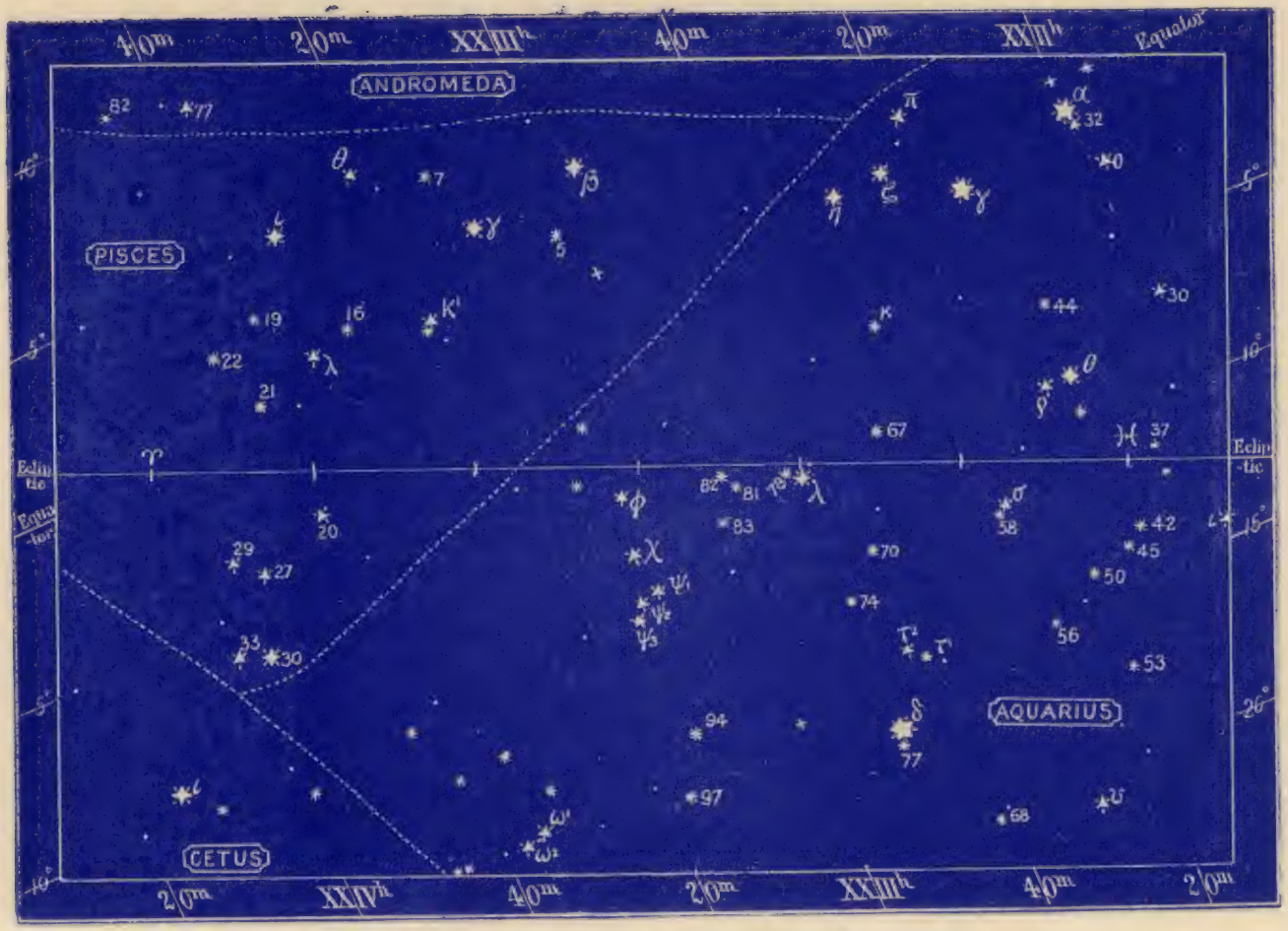
THE ZODIACAL SIGN CAPRICORNUS (CONSTELLATION SAGITTARIUS).

[*The centre of this map comes to the meridian at midnight on July 7.*]



THE ZODIACAL SIGN AQUARIUS (CONSTELLATION CAPRICORNUS).

The centre of this map comes to the meridian at midnight on August 7.

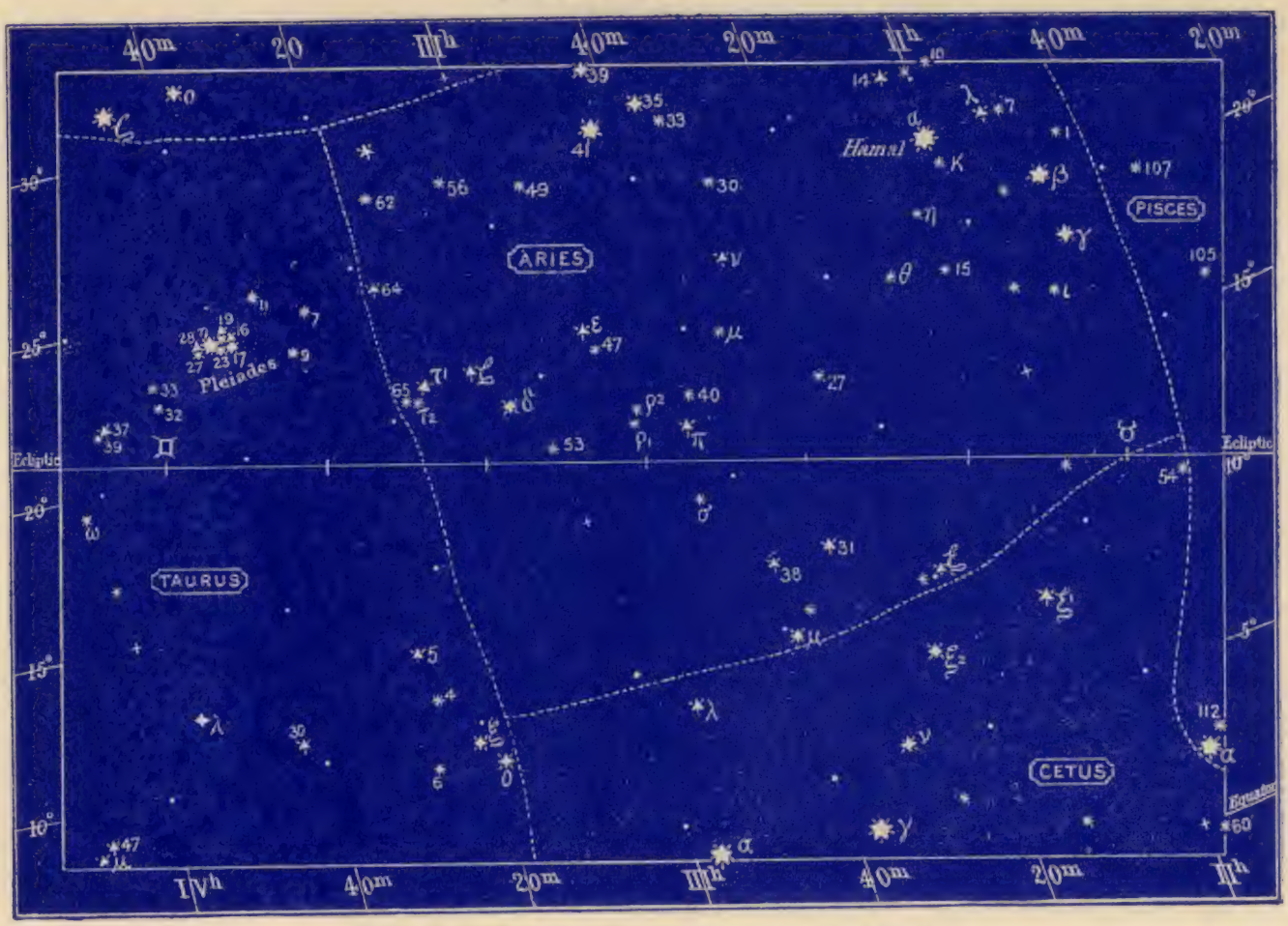


THE ZODIACAL SIGN PISCES (CONSTELLATION AQUARIUS).

[*The centre of this map comes to the meridian at midnight on September 7.*

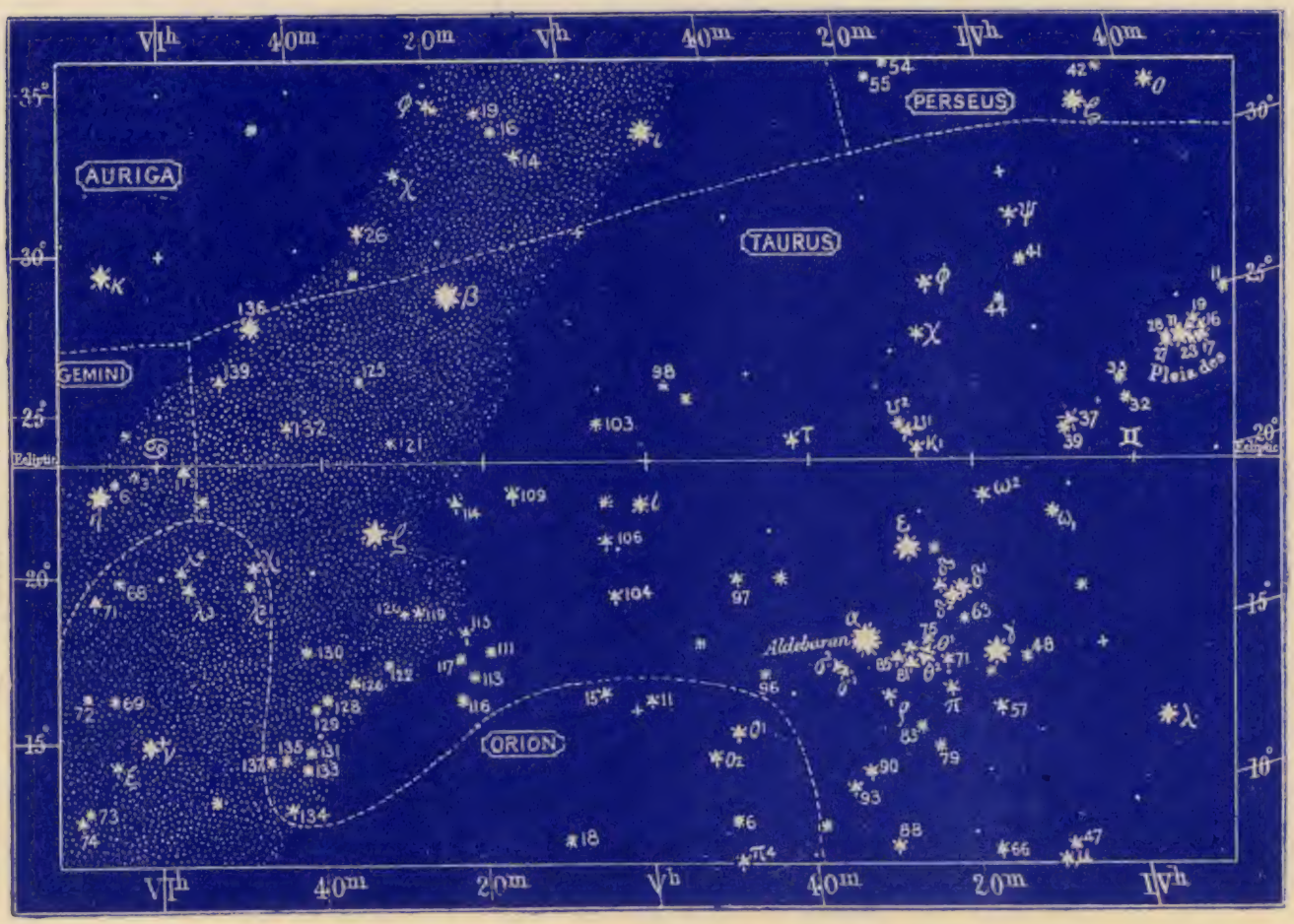
THE ZODIACAL SIGN ARIES (CONSTELLATION PISCES).

[*The centre of this map comes to the meridian at midnight on October 8.*



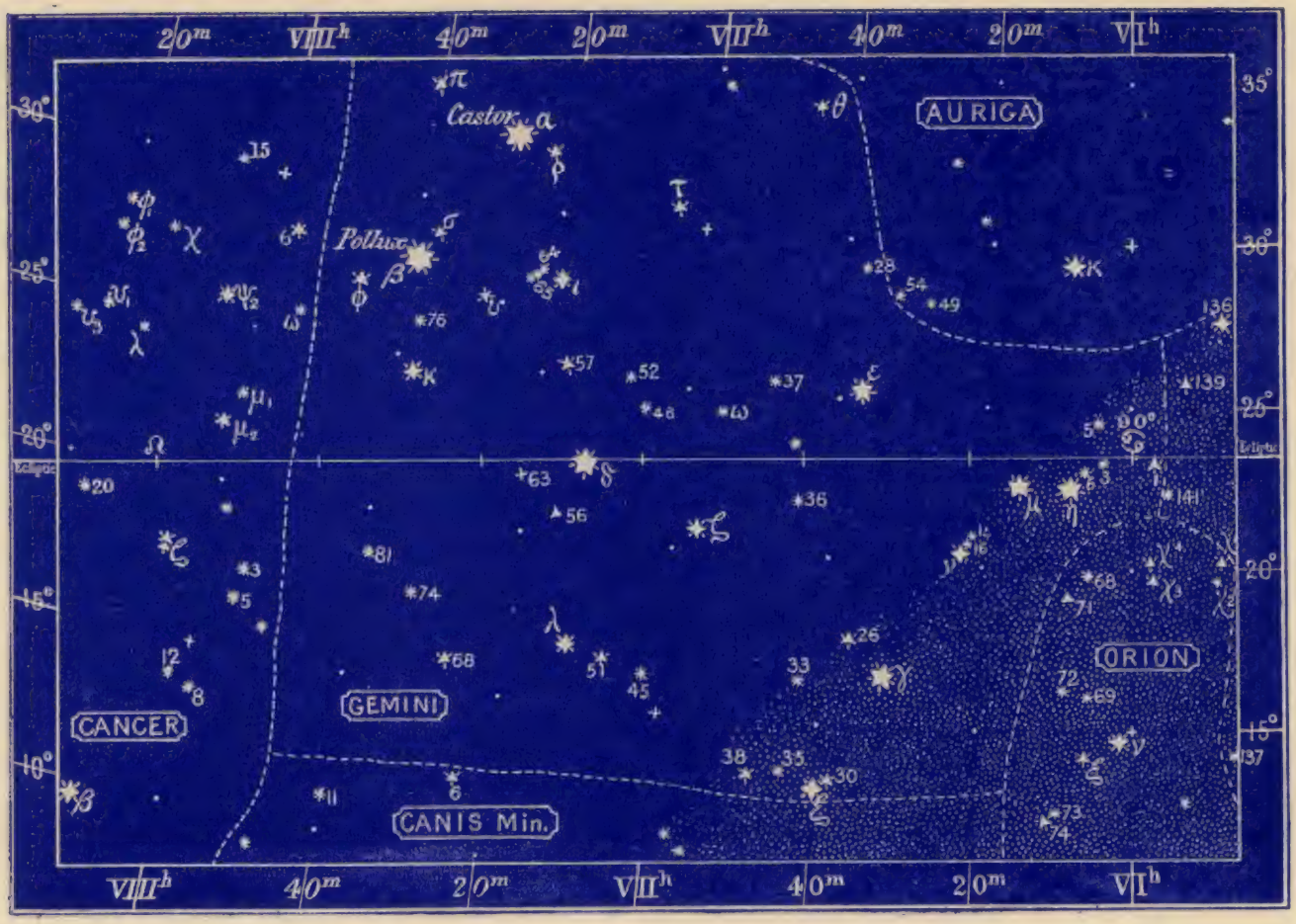
THE ZODIACAL SIGN TAURUS (CONSTELLATION ARIES).

[The centre of this map comes to the meridian at midnight on November 7.]



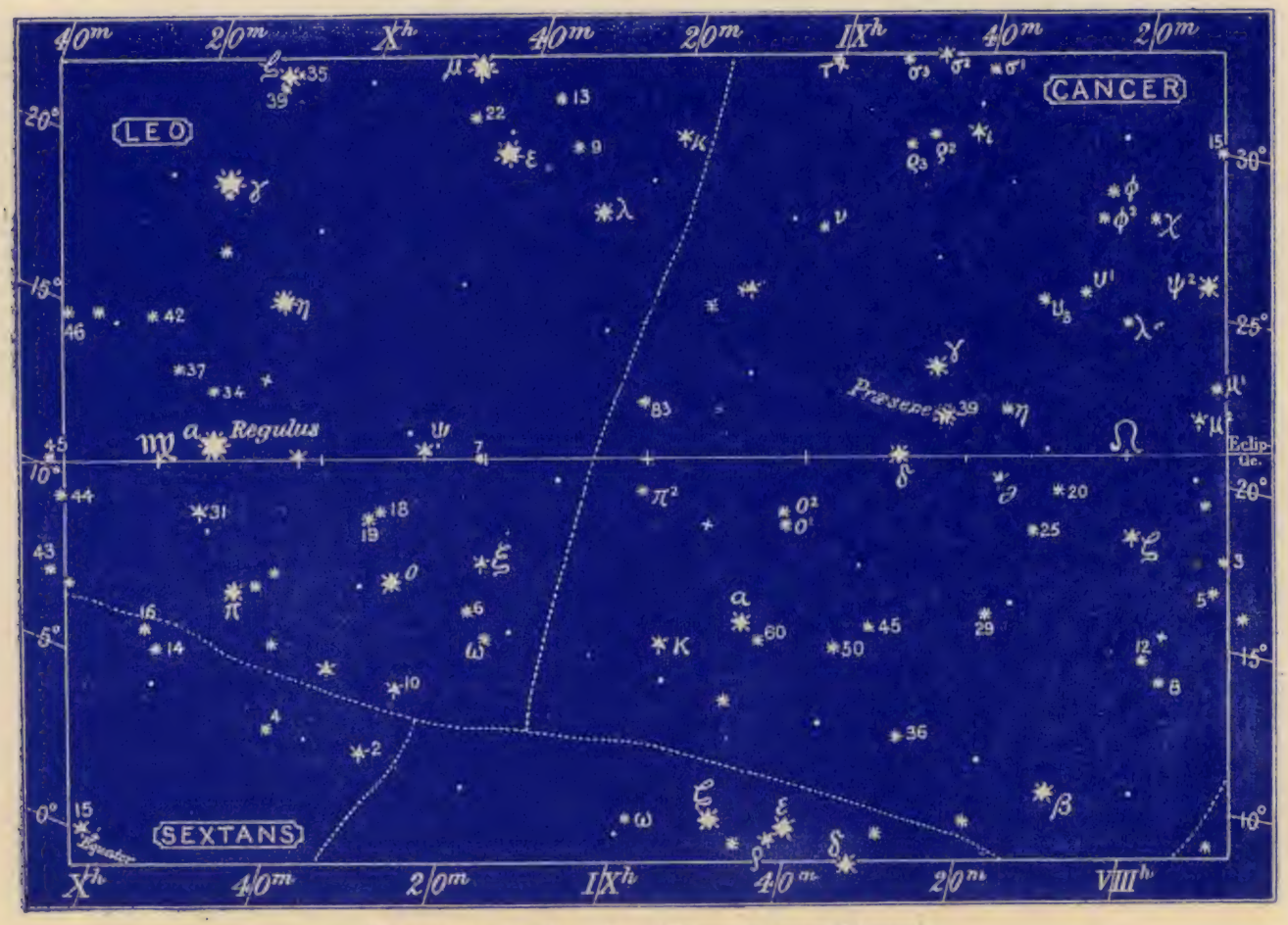
THE ZODIACAL SIGN GEMINI (CONSTELLATION TAURUS).

[The centre of this map comes to the meridian at midnight on December 6.]



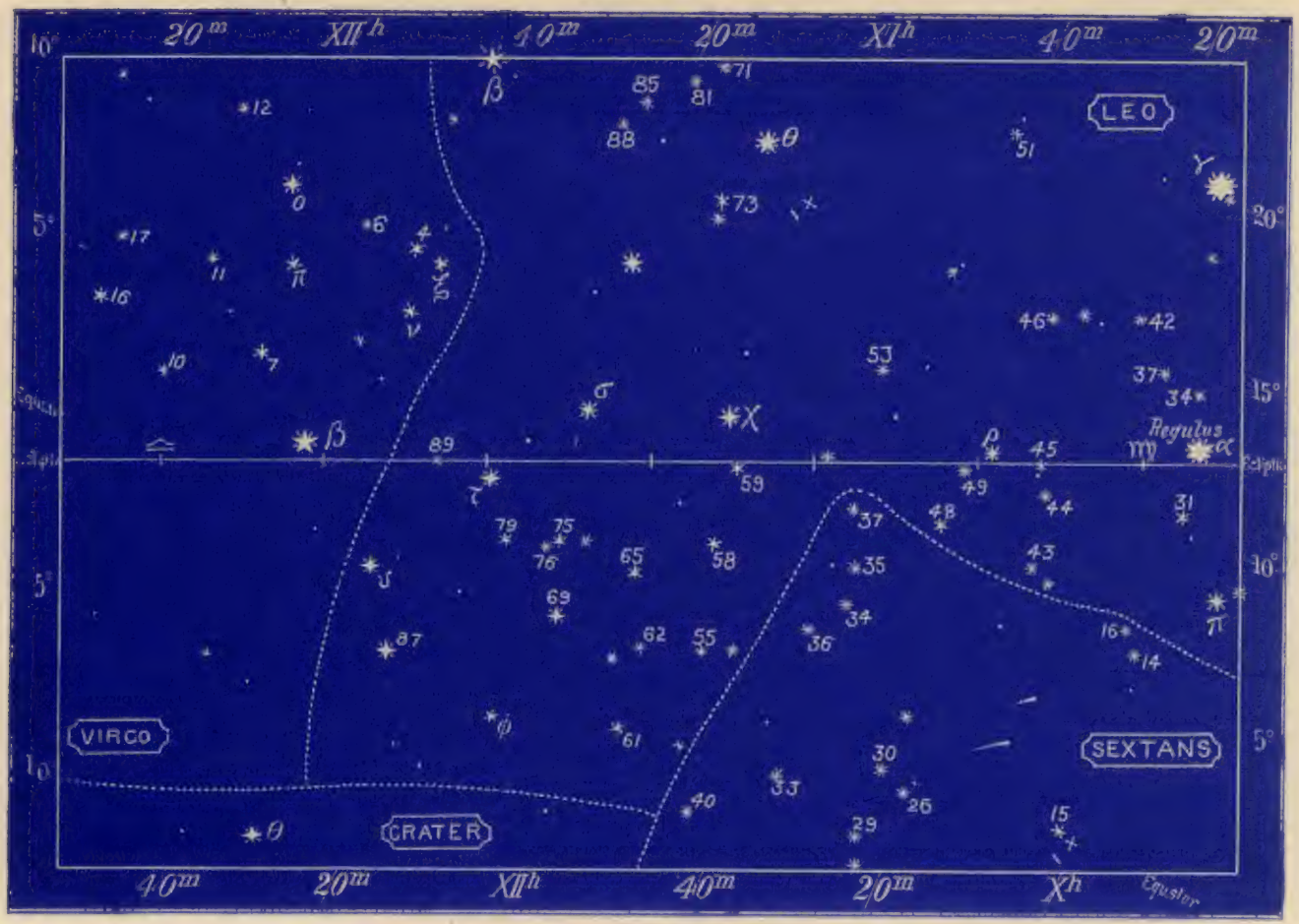
THE ZODIACAL SIGN CANCER (CONSTELLATION GEMINI)

[*The centre of this map comes to the meridian on January 5.*]



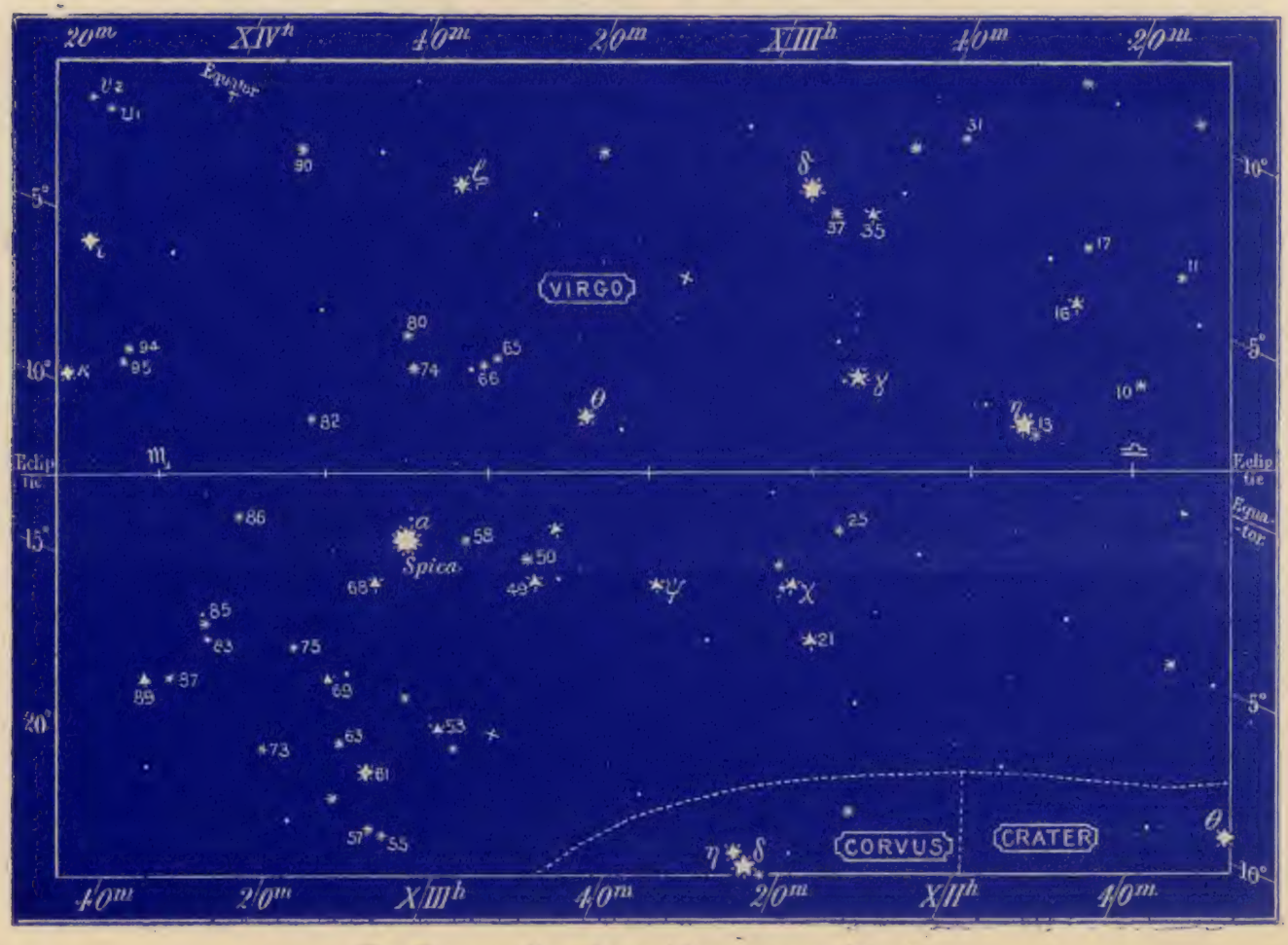
THE ZODIACAL SIGN LEO (CONSTELLATION CANCER).

[*The centre of this map comes to the meridian on February 3.*]

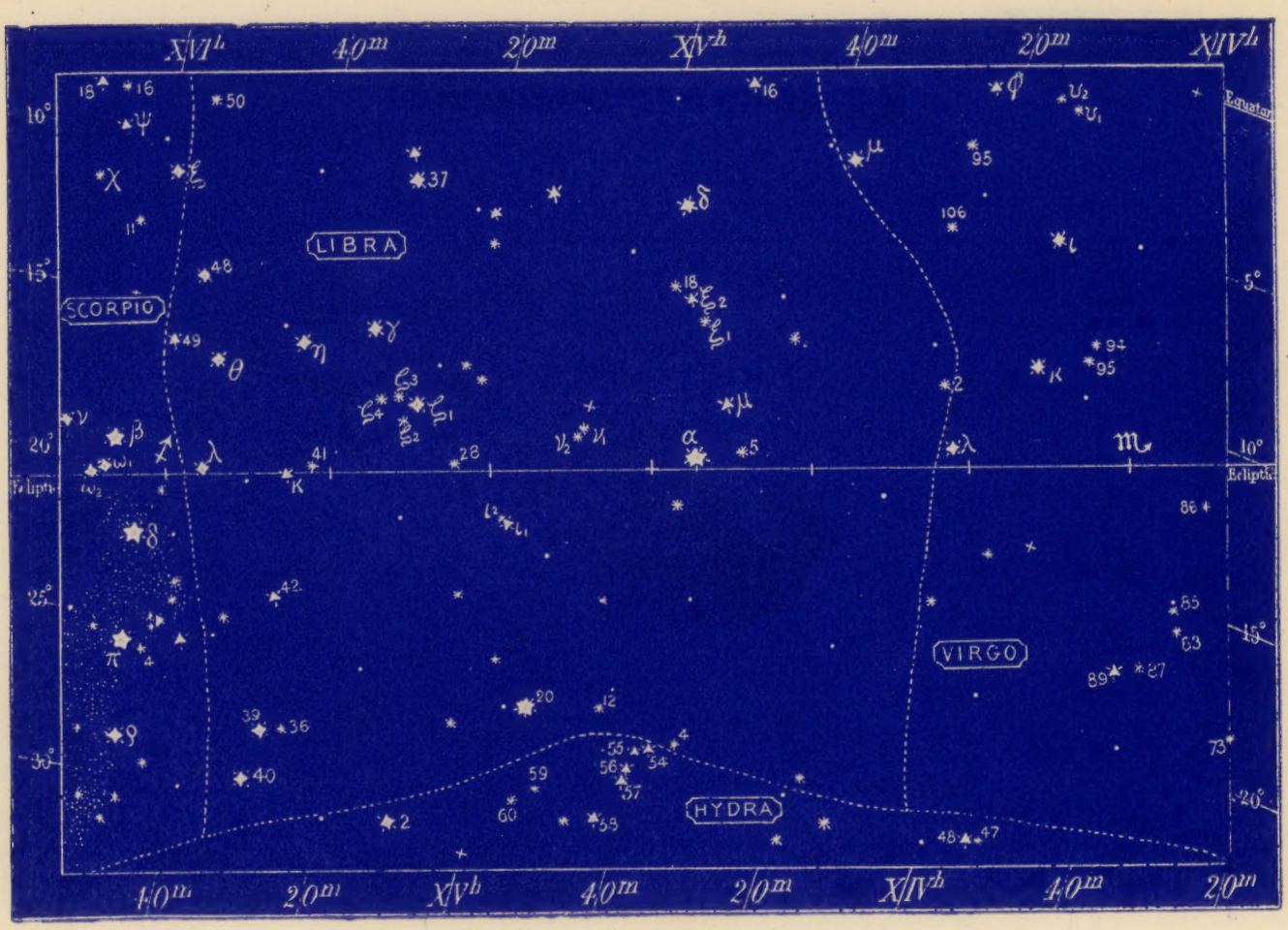


THE ZODIACAL SIGN VIRGO (CONSTELLATION LEO).

[*The centre of this map comes to the meridian on March 5.*]

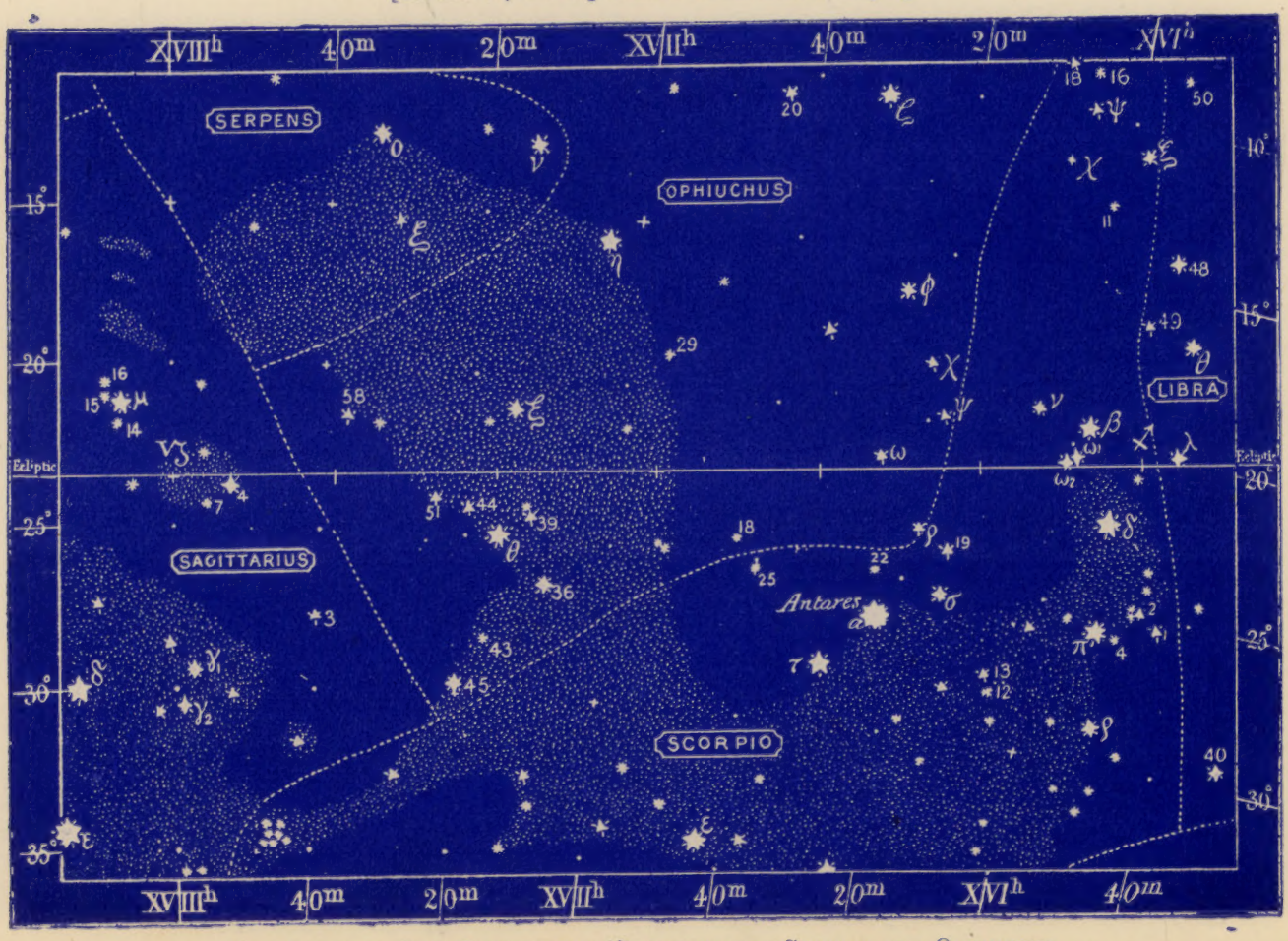


THE ZODIACAL SIGN LIBRA (CONSTELLATION VIRGO).



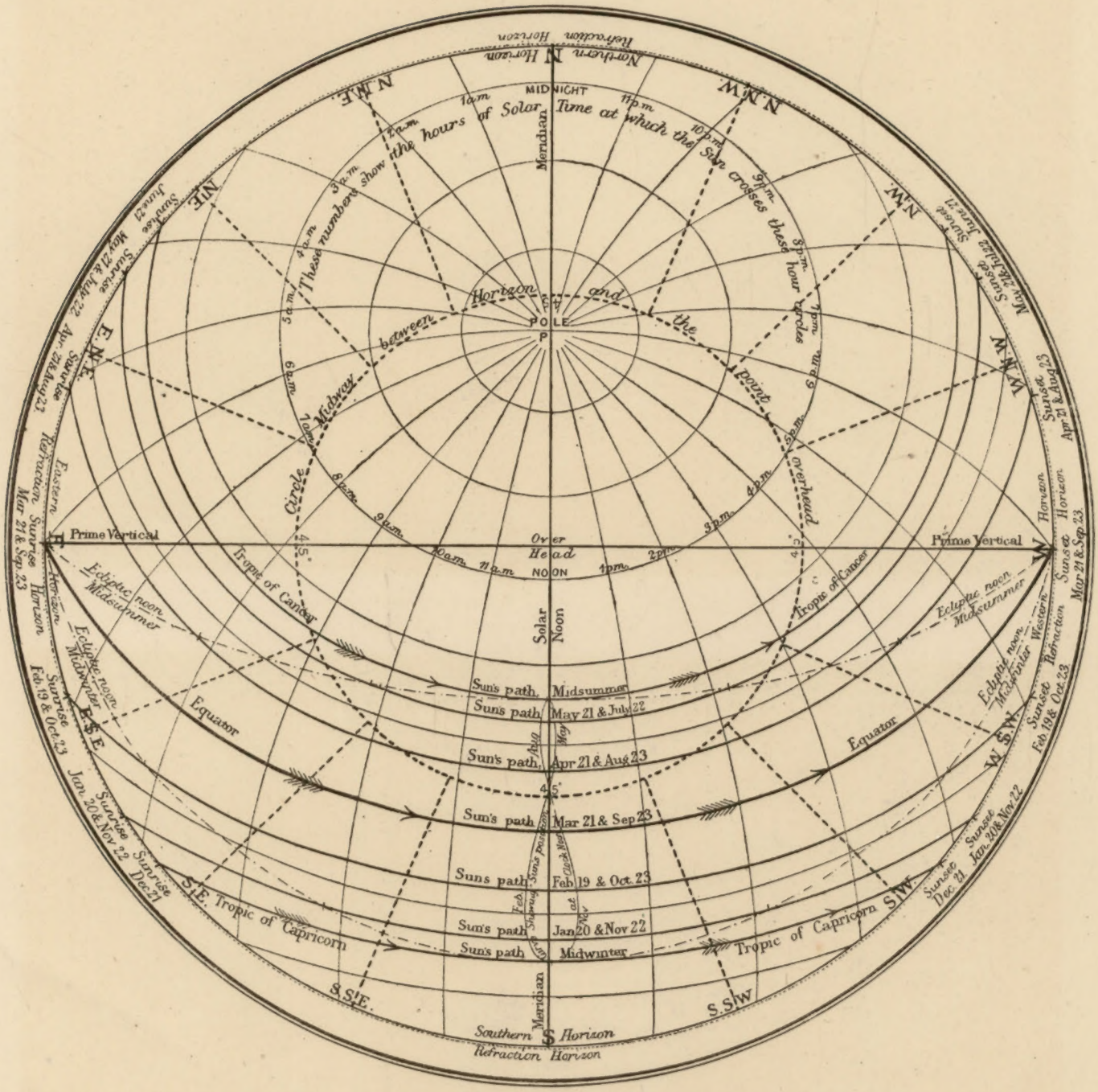
THE ZODIACAL SIGN SCORPIO (CONSTELLATION LIBRA).

[The centre of this map comes to the meridian on May 5.]



THE ZODIACAL SIGN SAGITTARIUS (CONSTELLATION SCORPIO AND OPHIUCHUS).

PLATE XXVII.



THE SUN'S DIURNAL COURSE THROUGHOUT THE YEAR.

In this Map equal distances from the centre represent equal distances on the sky from the point overhead. The double loop over the southern meridian passes through the clock-noon positions of the sun, and shows how much he is to the east of the meridian in January, February, March, &c. (and therefore after the clock), and how much he is to the west of the meridian (and therefore before the clock), in September, October, November, &c. It is not meridianally symmetrical.

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